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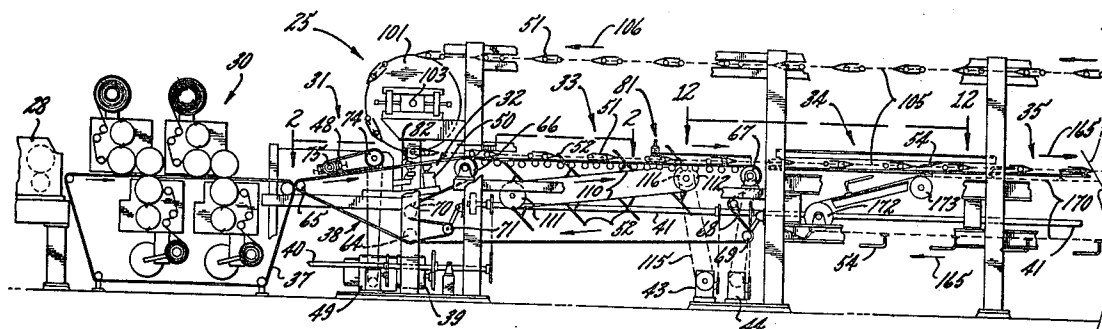
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[54] **METHOD AND APPARATUS FOR FOLDING
DISPOSABLE DIAPERS**
29 Claims, 24 Drawing Figs.

[52] U.S. Cl. 270/61,
223/37
[51] Int. Cl. B65h 45/00
[50] Field of Search 270/61;
223/37

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ABSTRACT: A method and apparatus for folding precut sheet material, such as disposable diaper blanks, as they move in spaced-apart relation along a conveyor path. The folder includes apparatus for preliminarily folding the blank along a medially located transverse fold line and over a triangular-shaped folding board and further apparatus for diagonally folding over the legs of the folding board the material initially located along the transverse fold line on either side of the center thereof and for tucking this material between the upper and lower portions of the preliminarily folded blank while also reversely interfolding therebetween the material initially located along the transverse fold line most distant from the center thereof. The folding apparatus also includes means for picking the folded blank off the folding board and for stripping it from the picker. A preferred form of the apparatus also includes automatic glue guns for applying discrete spots of adhesive at specific points on the underside of the blank prior to the folding operation.



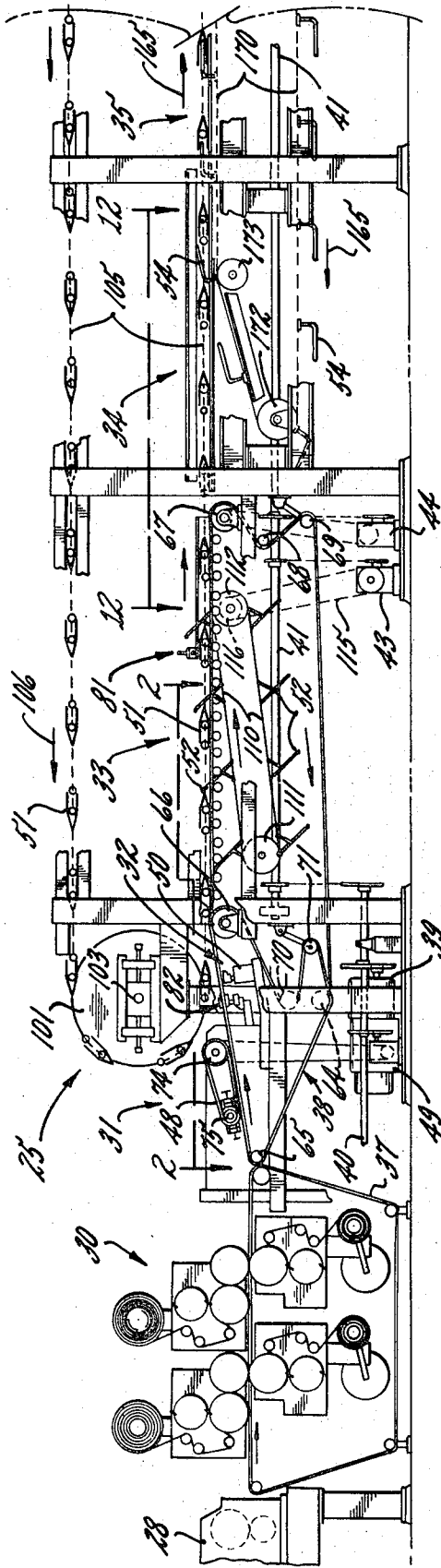


FIG. 1a.

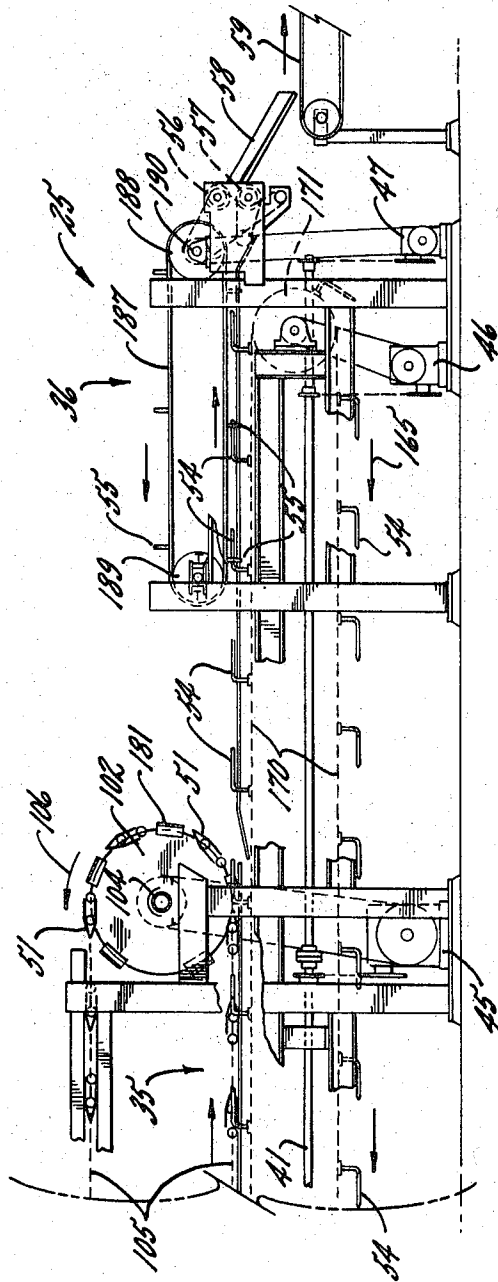
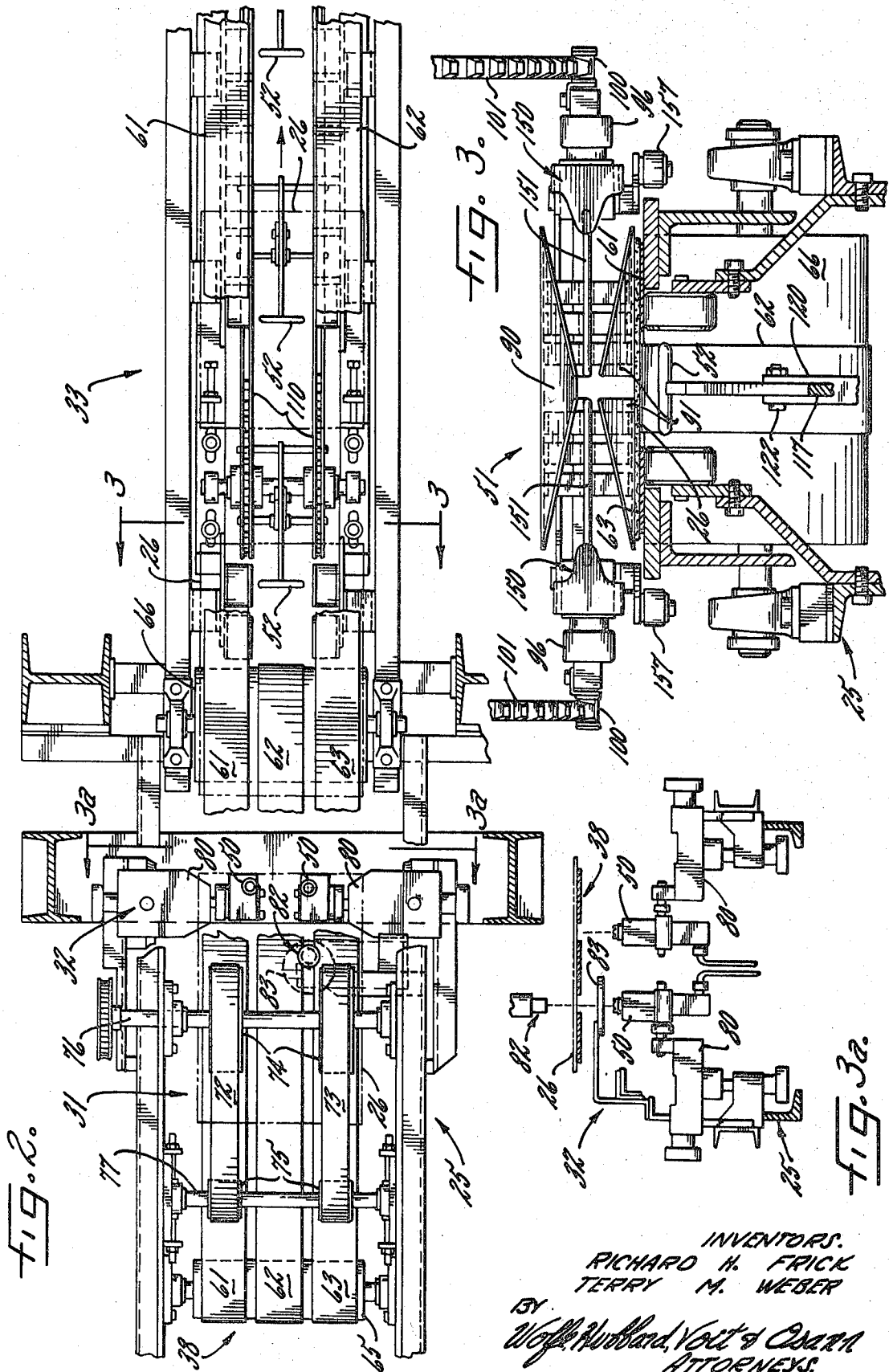
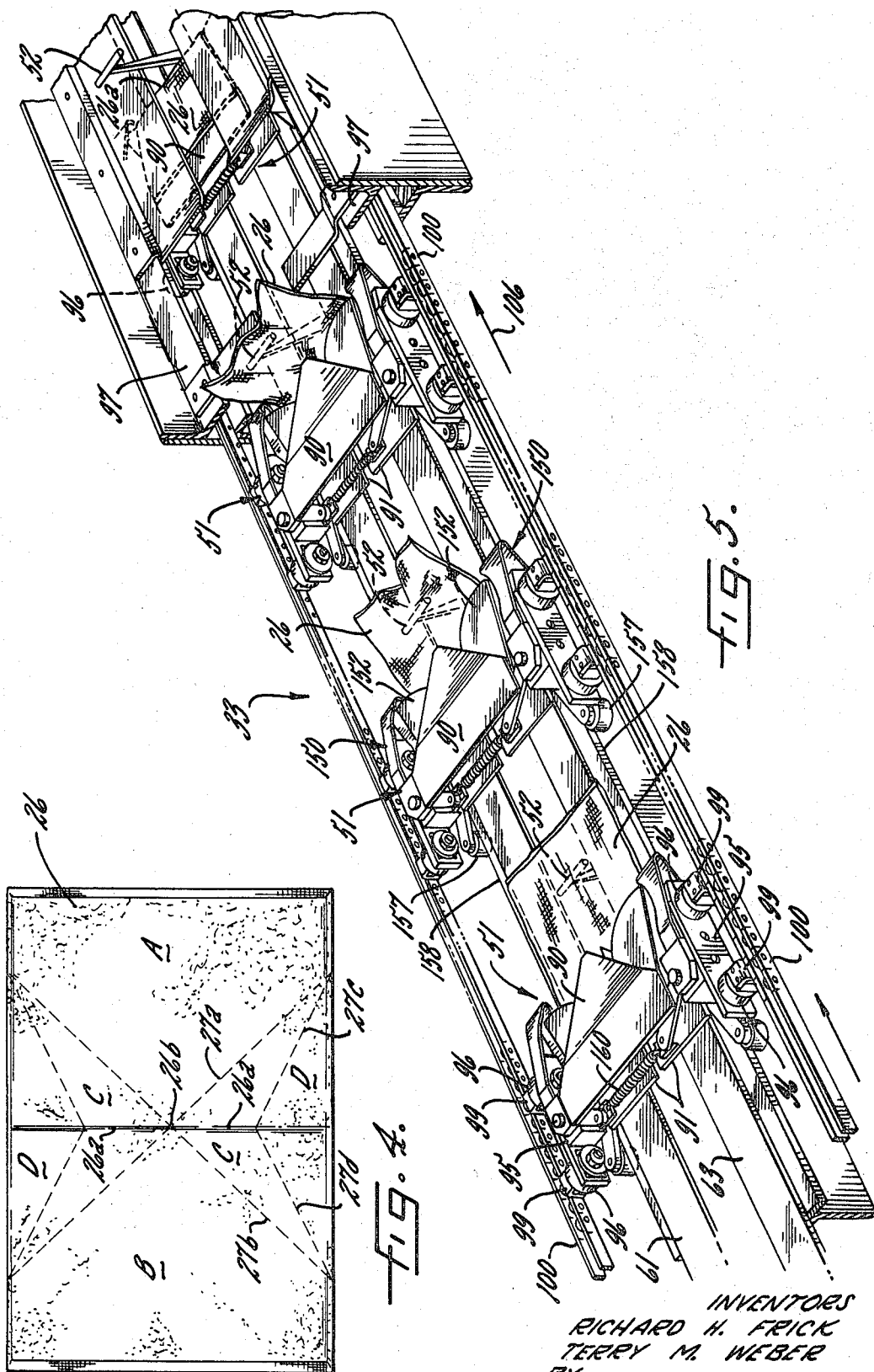


FIG. 1b.

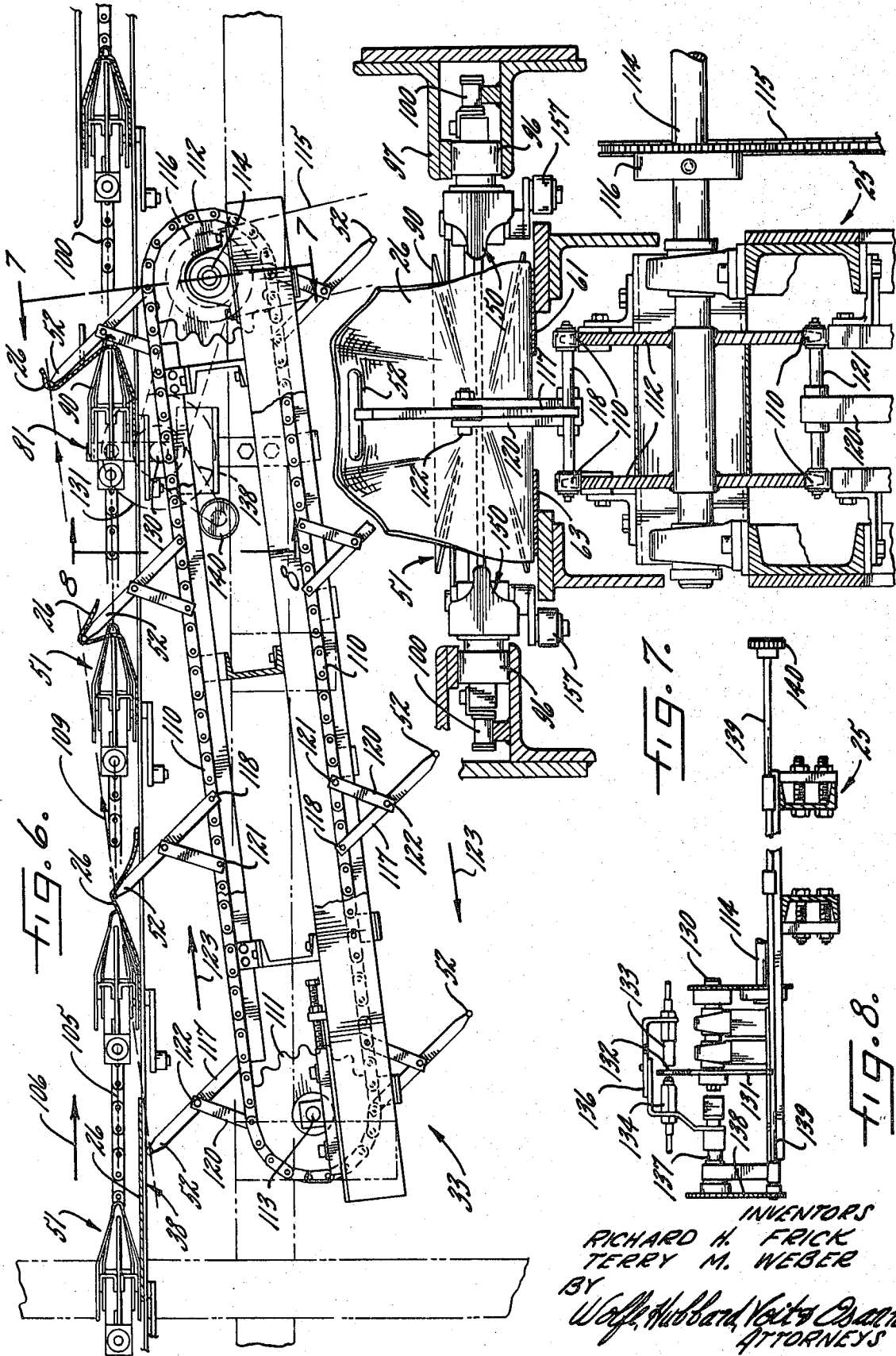
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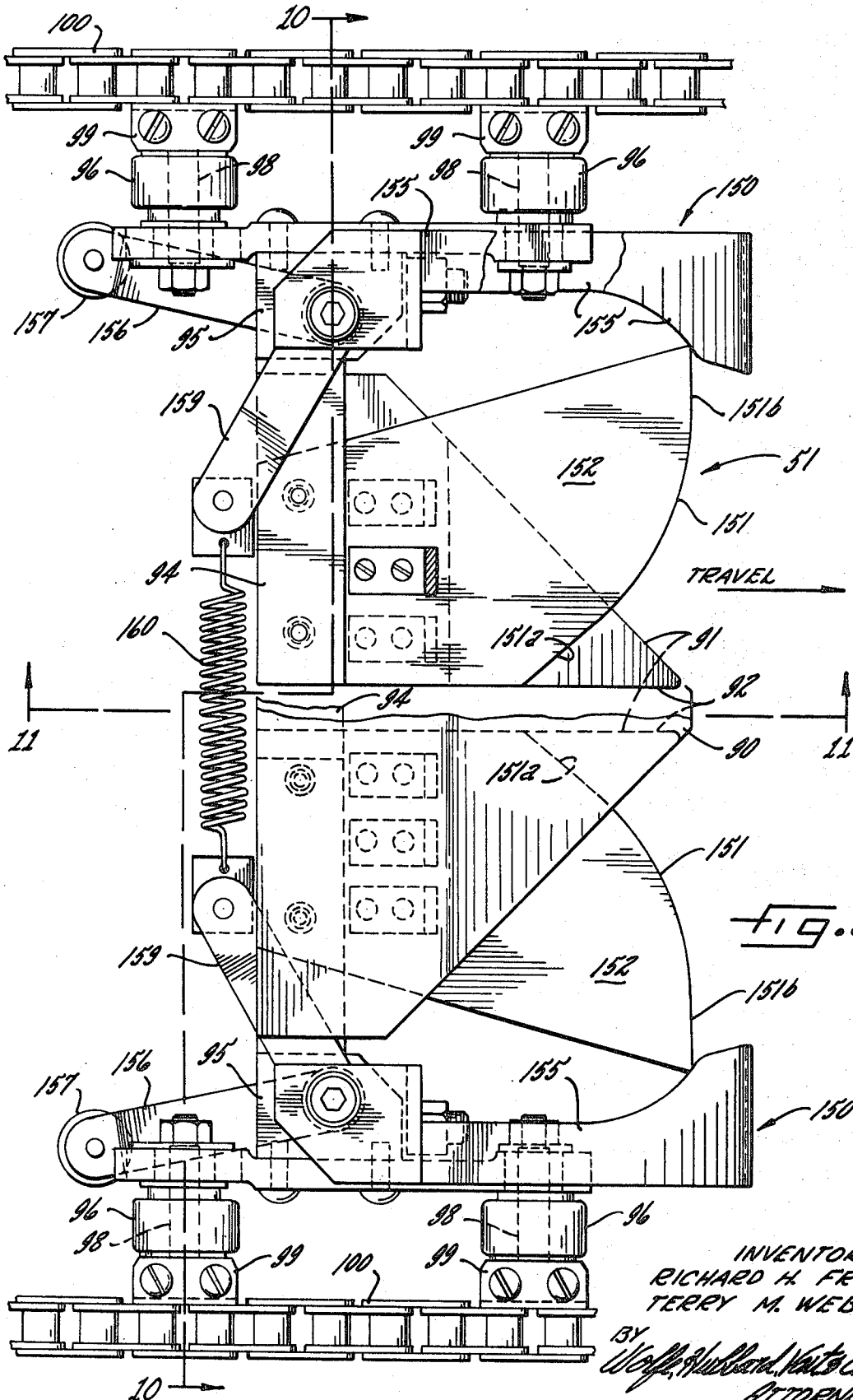
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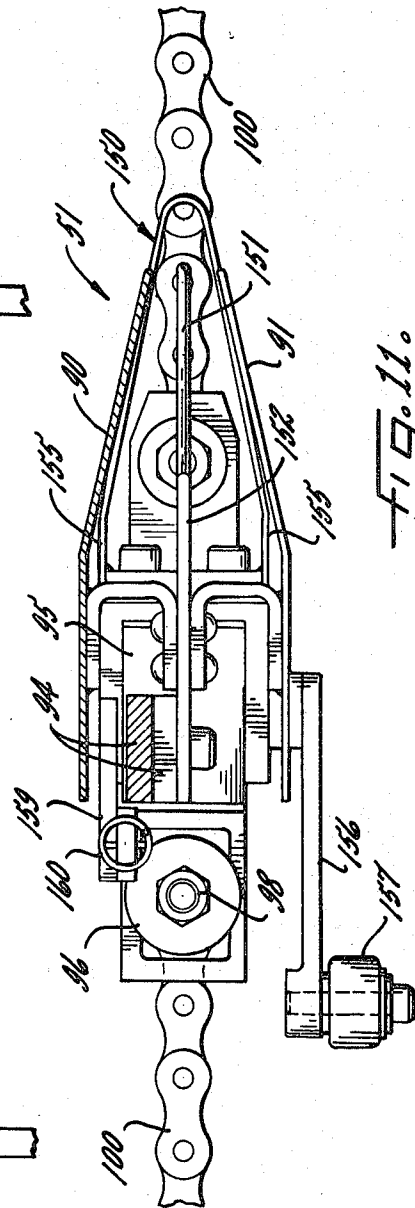
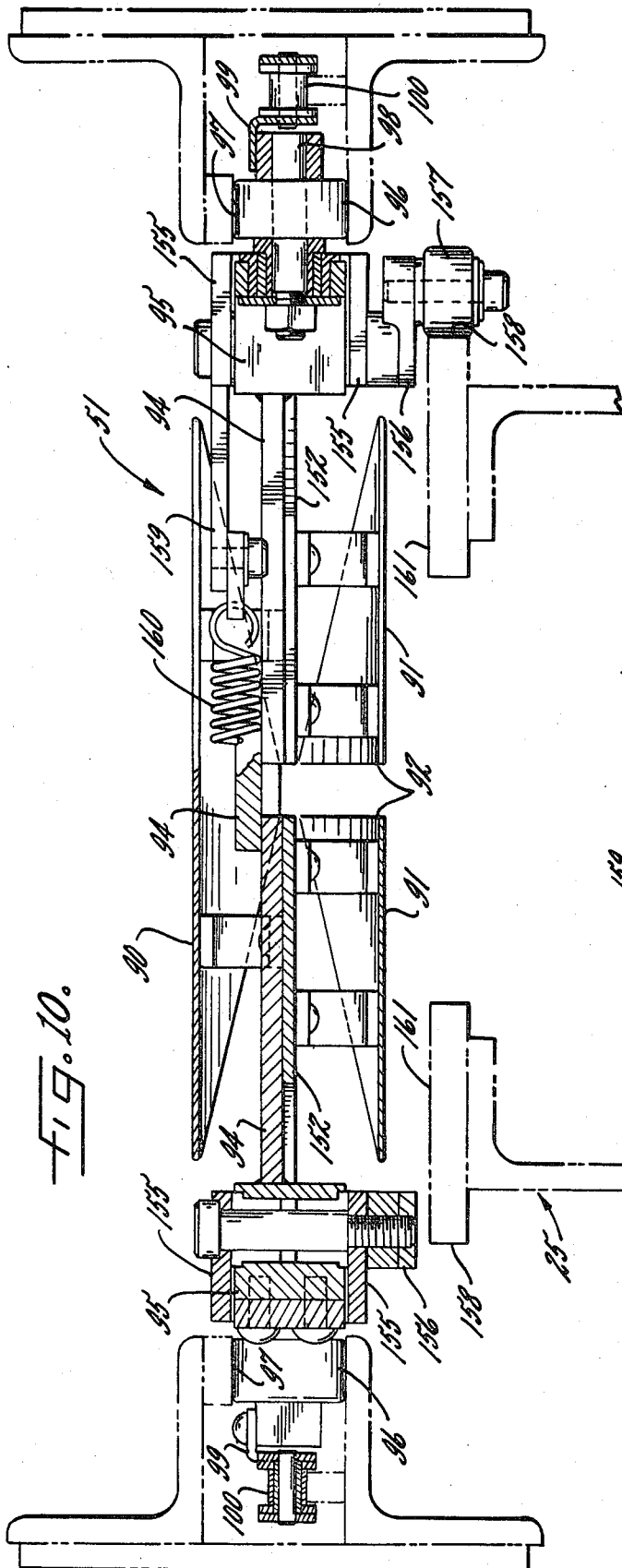


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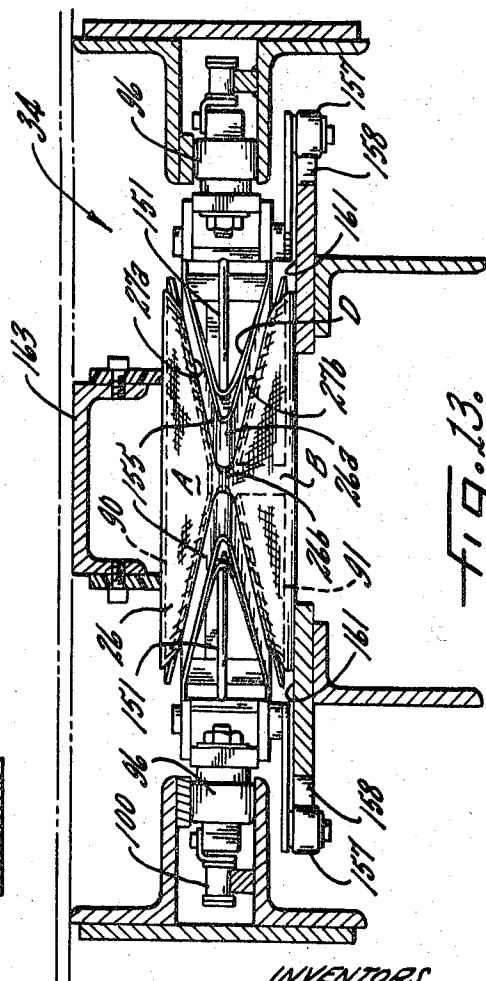
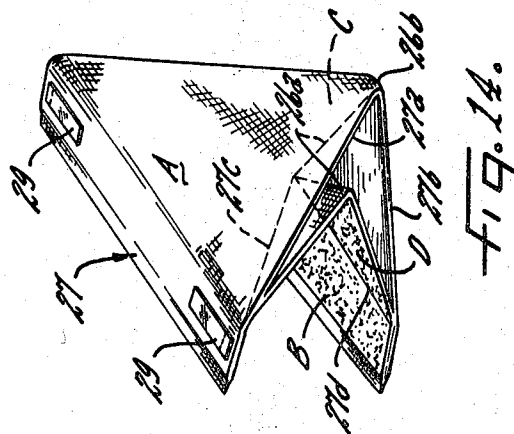
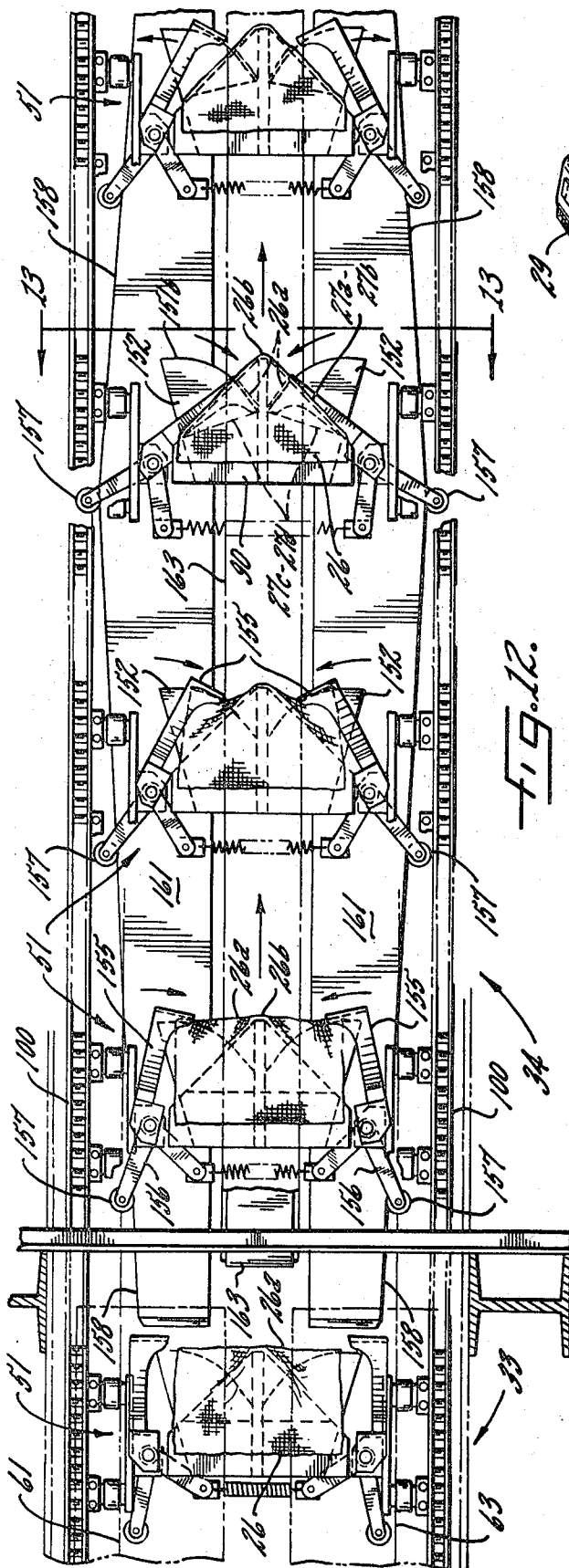


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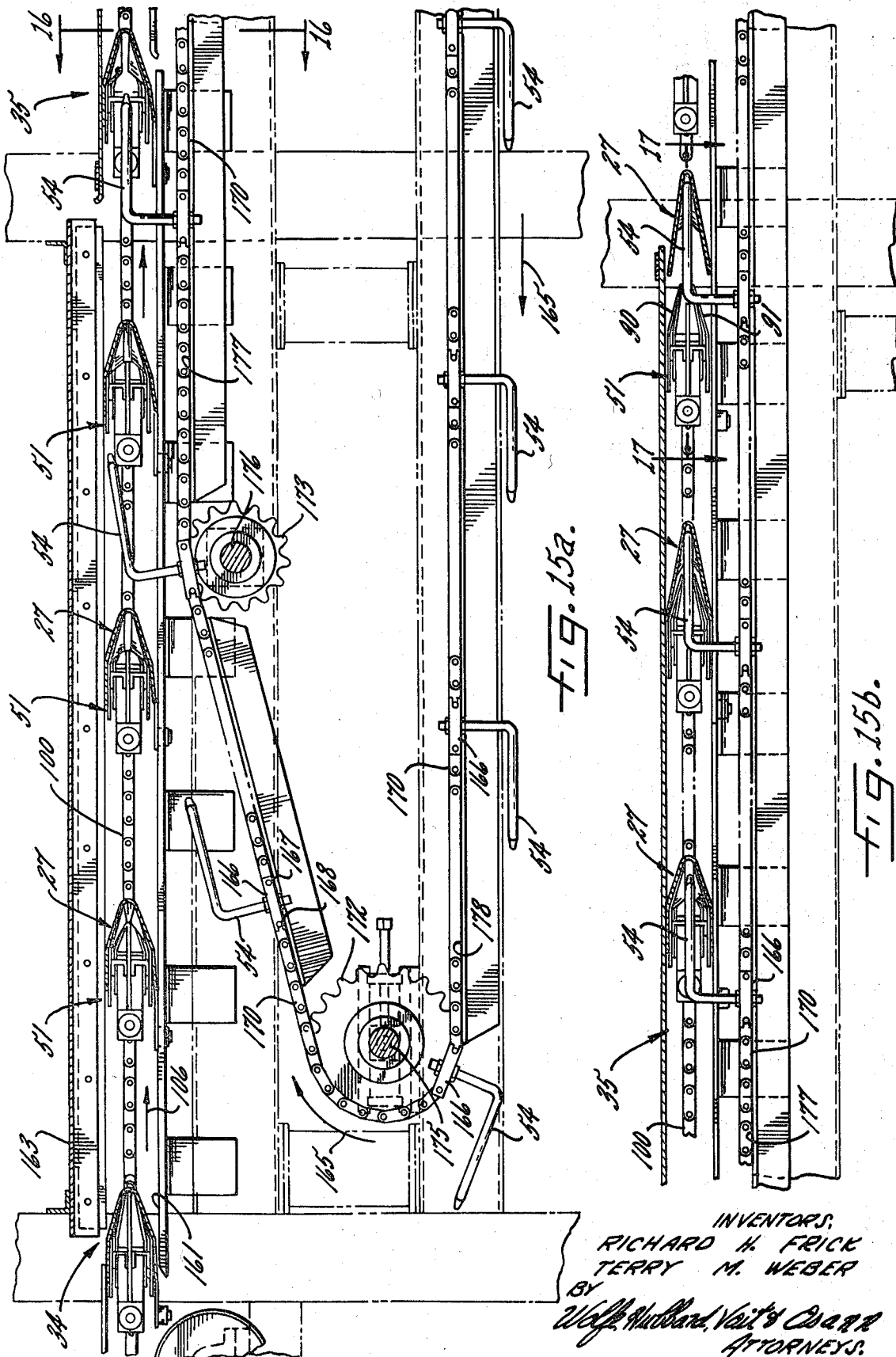


FIG. 15a.

FIG. 15b.

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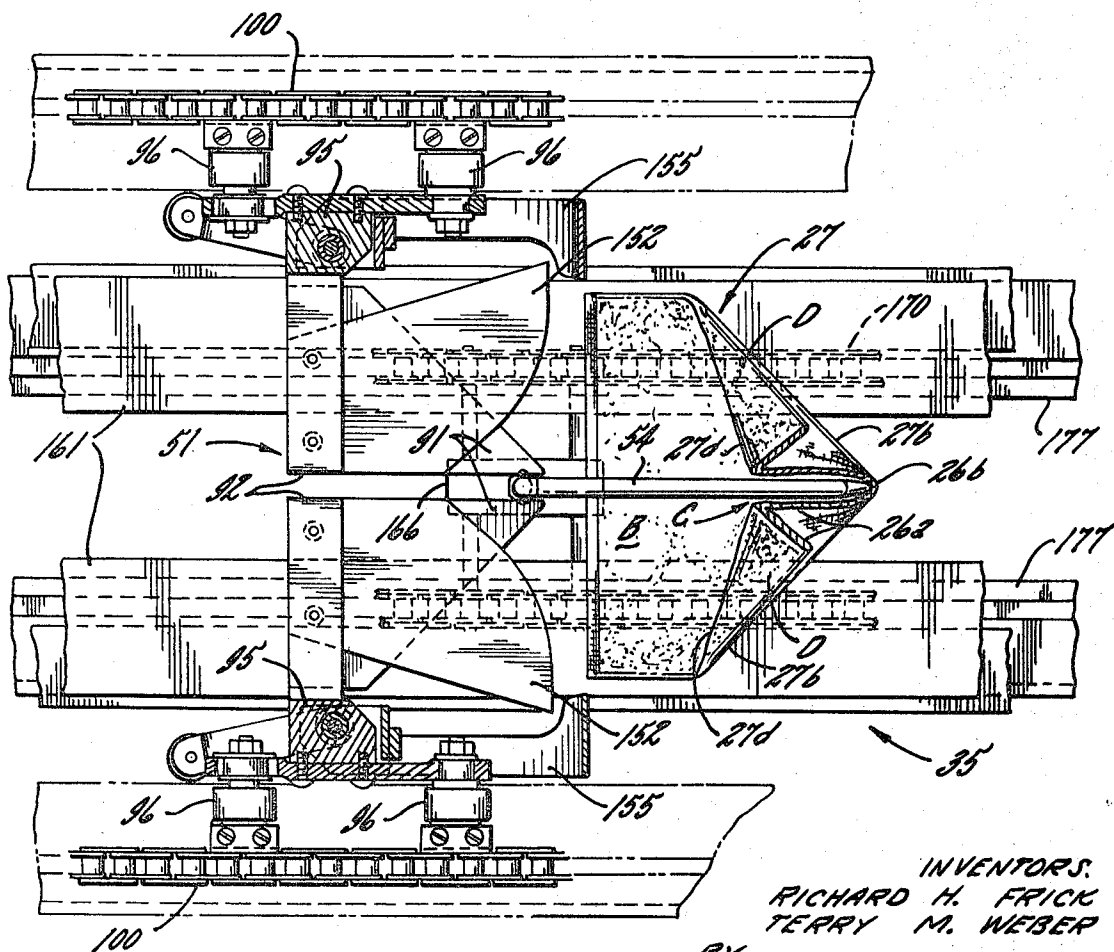
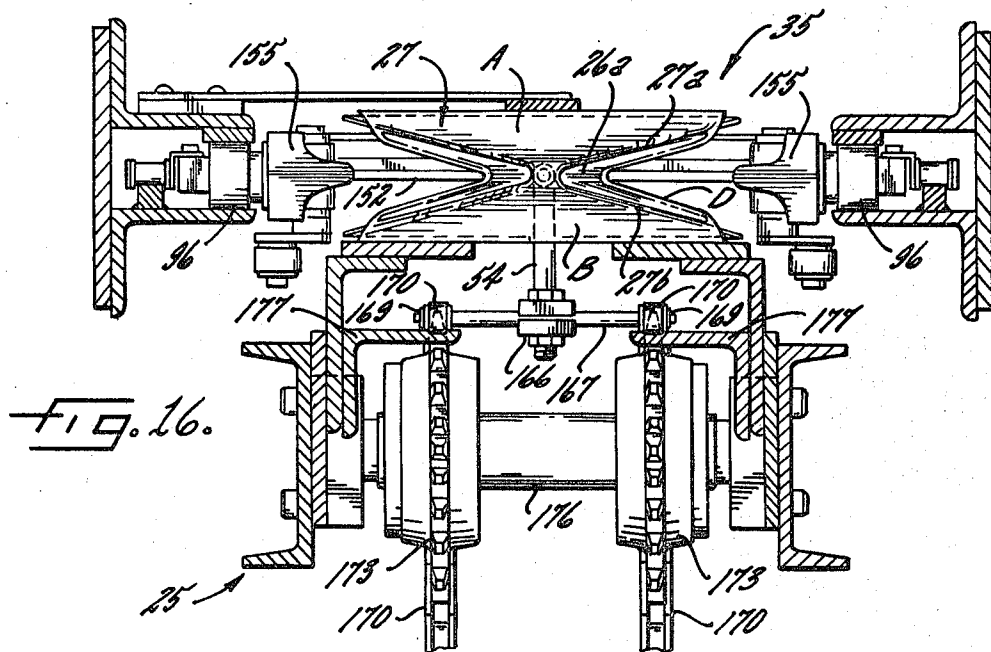
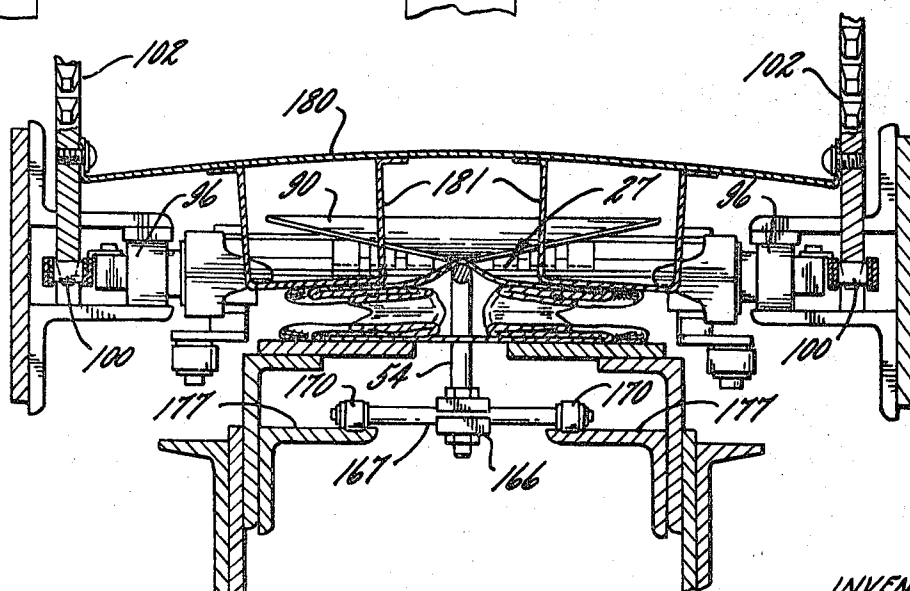
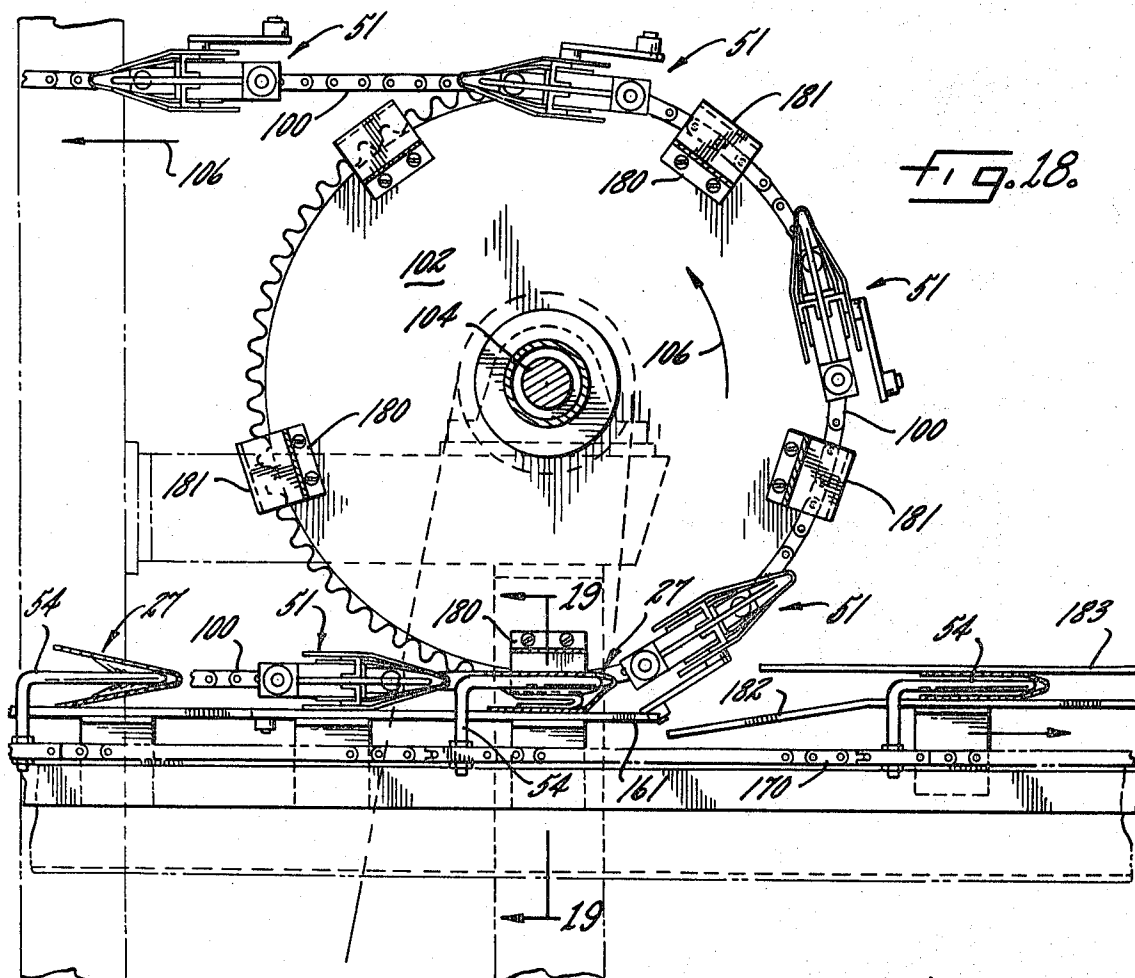


FIG. 17.

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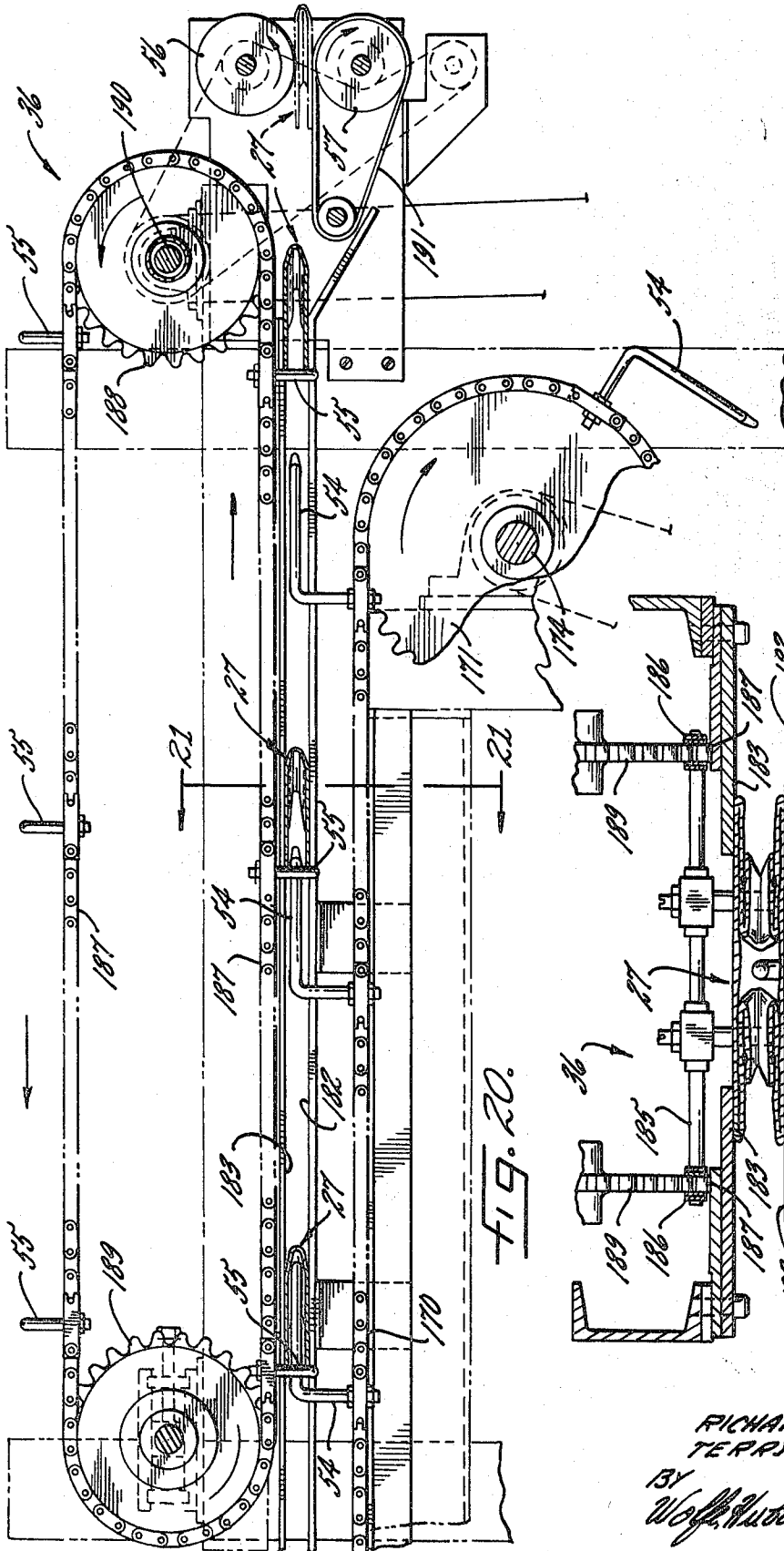


FIG. 20.

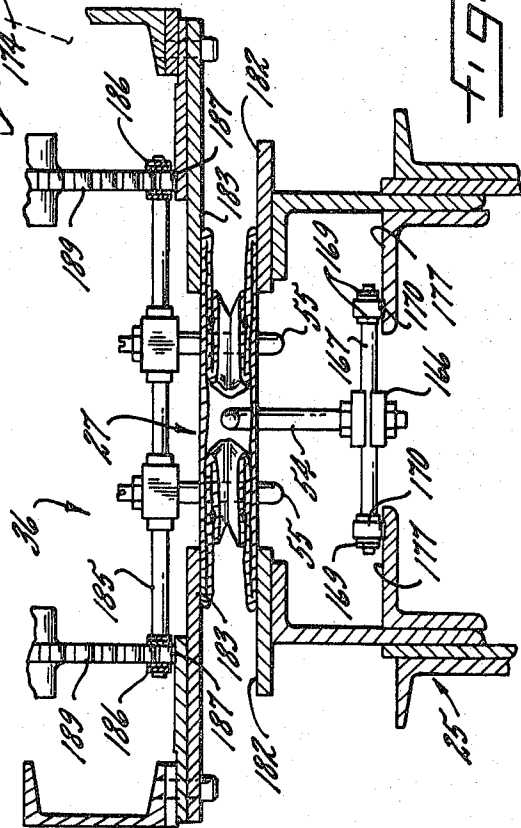


FIG. 21.

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METHOD AND APPARATUS FOR FOLDING DISPOSABLE DIAPERS

This invention relates primarily to sheet folding methods and apparatus and more particularly concerns automated methods and apparatus for folding disposable diapers into substantially child-conforming shape.

In recent years new materials and advanced manufacturing techniques have made possible the mass production of disposable diapers which can effectively compete with conventional laundered diapers. This is particularly true of those disposable diapers which include a fluid-impervious backing sheet that takes the place of the separate plastic or rubber panties normally required for use with conventional launderable diapers. However, the incorporation of such a fluid-impervious exterior for disposable diapers makes it even more essential that the diaper be properly folded into a body-conforming shape in order to enhance the holding capacity of the diaper as well as avoid unnecessary contact of the impervious cover with the infant's skin which might cause irritation.

A disposable prefolded diaper meeting the foregoing requirements is disclosed in Hrubecy, U.S. Pat. No. 3,196,874. As disclosed there such diapers are machine embossed or otherwise creased along designated prefold lines to facilitate subsequent folding of the diaper into substantially child-conforming and excrement entrapping configuration. This does, of course, make it much easier to prefold the diaper; but, nevertheless, even with skilled personnel the number of diapers that can be folded is limited.

Accordingly, it is the primary aim of the present invention to provide an automated method and apparatus for prefolding disposable diapers on a high volume production basis.

It is a more specific object to provide a method and apparatus for prefolding disposable diapers in the desired body-conforming shape as they move continuously along a flow path.

A more detailed object is to provide a method and apparatus for preliminarily folding a disposable diaper blank along a medially located transverse line and then to subsequently tuck the marginal portions of the diaper located along the preliminary fold line between the upper and lower surface of the diaper while also reversely interfolding therebetween the material initially located along the transverse fold line most distant from the center thereof.

Another object of the invention is to provide a method and apparatus for applying discrete spots of adhesive to specific spots on the diaper blank prior to folding, which adhesive spots are effective in retaining the diaper in its desired prefolded configuration.

Other objects and advantages of the invention will become more readily apparent upon reading the following detailed description and upon reference to the drawings in which:

FIGS. 1a and 1b are, respectively, side elevations of the blank receiving and discharge ends of the folding apparatus of the present invention;

FIG. 2 is an enlarged fragmentary section taken along line 2-2 in FIG. 1;

FIG. 3 is an enlarged fragmentary section and FIG. 3a is a fragmentary section, respectively, taken along lines 3-3 and 3a-3a in FIG. 2;

FIG. 4 is a plan view of a precut diaper blank before folding;

FIG. 5 is an enlarged fragmentary perspective view of the apparatus for initially folding the blank across a transverse fold line;

FIG. 7 is a side elevation of the apparatus shown in FIG. 5;

FIGS. 7 and 8, respectively, are further enlarged fragmentary sections taken along lines 7-7 and 8-8 in FIG. 6;

FIG. 9 is an enlarged fragmentary plan view of one of the folding boards and side tucking assemblies;

FIGS. 10 and 11, respectively, are sections taken along lines 10-10 and 11-11 in FIG. 9;

FIG. 12 is a fragmentary plan view of the side tucking portion of the folding apparatus shown in FIG. 1;

FIG. 13 is an enlarged fragmentary section taken along line 13-13 in FIG. 12;

FIG. 14 is a perspective view of a previously folded blank, partially unfolded to illustrate the interfolded portions;

FIGS. 15a and 15b, respectively, are enlarged fragmentary side elevations of portions of the apparatus shown in FIGS. 1a and 1b;

FIGS. 16 and 17, respectively, are fragmentary sections taken along lines 16-16 in FIG. 15a and 17-17 in FIG. 15b;

FIG. 18 is an enlarged fragmentary side elevation of a further portion of the apparatus shown in FIG. 1b;

FIG. 19 is an enlarged fragmentary section taken along line 19-19 in FIG. 18;

FIG. 20 is an enlarged fragmentary side elevation of the final portion of the apparatus shown in FIG. 1b; and,

FIG. 21 is an enlarged fragmentary section taken along line 21-21 in FIG. 20.

Turning now to the drawings, FIGS. 1a and 1b, when taken together, comprise a side elevation of the folding apparatus 25 of the present invention. This folding apparatus has particular utility in automatically folding precut diaper blanks 26 (see FIG. 4) into diapers 27 (see FIG. 14) which have a substantially child-conforming shape as disclosed in Hrubecy, U.S. Pat. No. 3,196,874 assigned to the instant assignee. However, it should be understood that certain aspects of the apparatus 25 also have utility for folding other precut blanks of material in addition to diapers.

In their preferred form, the diaper blanks 26 are of multilayer construction such as disclosed in copending Endres application Ser. No. 715,301, filed Mar. 22, 1968, now U.S. Pat. No. 3,520,303, to which reference may be made for further details. Such diaper blanks may be made on a disposable diaper forming apparatus such as disclosed in copending Frick application Ser. No. 776,580, filed Nov. 18, 1968 to which reference may also be made for further details of the blank forming apparatus. Both of the foregoing applications are also assigned to the instant assignee.

The particular construction of the diaper blanks and the apparatus for making them, however, need not follow the teaching of the two above-mentioned applications. Rather the blanks can be of other constructions formed on other types of apparatus and, indeed, as noted above need not be intended for diapers insofar as practicing certain aspects of this invention as described below. Accordingly, only the discharge portion of a blank forming apparatus 28 is illustrated in FIG. 1a and it will be understood that it need not be disposed inline with the folding apparatus 25 which is the subject of the present application.

Similarly, although the preferred diapers 27 are provided with a pair of adhesively faced tapes 29 for convenience in holding the diapers on a child, such tapes are not important to the present invention and may be replaced with conventional diaper pins if desired. Thus, while a tape applying machine 30 has been illustrated generally in FIG. 1a as interposed between the blank forming apparatus 28 and the folding apparatus 25 of the present invention, the tape machine can also be omitted. In any event it is of conventional construction and need not be discussed in detail here.

Viewed in terms of its operation the folding apparatus 25 of the present invention includes six operating sections, namely: a receiving and speedup section 31; a glue applying section 32; an initial folding section 33; a side tucking section 34; a pickoff section 35; and a stripping and discharge section 36. Each of these sections will be discussed in detail below; but, first a few comments about the preferred prefolded shape of the diaper and on the overall operation of the folding machine should be helpful in understanding the detailed descriptions which follow. Also, it will be appreciated that the apparatus shown in FIGS. 1a and 1b is somewhat schematic in form and that the diaper blanks have been omitted here to facilitate a clearer illustration of the various machine components.

As previously mentioned the preferred form of the prefolded diaper is of a substantially body-conforming and excrement entrapping configuration as disclosed in the above-mentioned Hrubecy patent. As illustrated here in FIG. 14, such a

prefolded diaper 27 is formed with front and rear triangularly shaped, body encircling portions A and B joined by a depending excrement trapping pocket C adapted to be disposed centrally in the crotch area and by reversely interfolded leg engaging portions D, only one of which is shown. This is the final product of the folding apparatus 25 disclosed here.

The initial diaper blank 26 is illustrated in FIG. 4 with a preliminary fold line indicated by a solid line 26a extending transversely across the diaper blank 26 through its center 26b. Diagonally disposed fold lines 27a and 27b which intersect at the center 26b to define the triangular legs of portions A and B are shown in dash lines as are intersecting interfold lines 27c and 27d which separate the pocket C from the leg engaging portions D on each side of the longitudinal center line of the diaper blank 26.

Returning now to FIG. 1a and proceeding from the left, precut diaper blanks 26 from the forming apparatus 28 pass in end-to-end relation through the tape machine 30 on a conveyor 37 and are received by a conveyor 38 at the speedup section 31 of the folding apparatus 25. Both of the conveyors 37, 38 are preferably driven in timed relation by a main drive motor 39 through a common drive shaft 40. As shown in FIG. 1a, the drive shaft 40 drives a lay shaft 41 which runs along the length of the folding machine 25 and which is coupled to a series of gear transfer cases 43—47 through appropriate chain or timing belt connections. The conveyor 38 is driven from transfer case 44 and the conveyor 37 is driven at a slightly slower speed by a similar lay shaft and gear transfer arrangement, now shown.

As the diaper blanks begin to travel on the conveyor 38 they are also intercepted by an overlying conveyor 48 driven from the shaft 40 through a gear case 49 at the same speed as the conveyor 38. Thus as each diaper blank is engaged by conveyor 38 and 48 it is propelled forward at a greater speed than the next trailing blank on conveyor 37 resulting in a predetermined longitudinal spacing of the blanks along the conveyor 38.

The diaper blanks are received on the conveyor 38 with their outside, preferably a fluid-imperious layer, facing down. Prior to entering the folding section 33 they pass over a pair of glue guns 50 in the glue-applying section 32. The glue guns are actuated in timed relation to the movement of the diapers on the conveyor 38 such that two discrete spots of adhesive are applied to the underside of the diaper blank at specific points prior to the folding operation.

From the glue section 32 the diaper blanks pass into the initial folding section 33 where each diaper blank is engaged by one of a plurality of folding boards 51 mounted for movement about a conveyor loop disposed in part parallel to the conveyor 38. The timing of the folding boards 51 which are driven from the lay shaft 41 through gear case 45 is such that each folding board engages the rear half of its respective diaper blank and then travels in unison with the conveyor 38. The initial folding section 33 also includes a plurality of folding bars 52 mounted for continuous movement along a second loop disposed in part to intersect the common path of the conveyor 38 and folding boards 51 from below at an acute angle. The folding bars 52 are driven from the lay shaft 41 through gear case 43 in timed sequence with the movement of the blanks on conveyor 38 but at a lower rate of speed so that each folding bar periodically engages and progressively lifts and folds the leading portion of respective ones of the blanks over the upper surface of the folding board as the folding bar moves from below and ahead to above and behind the forward portion of the folding board. This results in preliminarily folding the diaper blank over the folding board 51 along transverse fold line 26a (see FIG. 4). The folding bars 52 are then drawn out of engagement with their respective diaper blanks as the blanks enter the side tucking section 34 of the folding machine 25.

In the side tucking section 34 additional elements of the forming board 51 are actuated (as will be described below) to interfold the diaper blank along diagonal fold lines 27a—d

(see FIG. 4) to form the diaper into the body-conforming shape illustrated in FIG. 14.

Following the folding operation each diaper blank is removed from its folding board 51 by one of a plurality of picker pins 54 mounted for continuous movement along a conveyor loop disposed in part parallel to the lower path of the folding boards. The picker pins are driven by the lay shaft 41 through gear case 46 in timed relation with the folding boards 51 but at a faster speed such that each picker pin moves along its upper path from behind one of the folding boards to ahead of the folding board pushing the diaper blank off the folding board before it makes its return loop.

Subsequently, the diaper blank is removed from the picker pin 54 by a stripper element 55 driven along a continuous loop above the picker pin loop by the lay shaft 41 through the gear case 47. The stripper element 55 is driven in timed relation with, but at a faster speed than, the picker pin 54 such that the diaper blank is pushed off the picker pin and is discharged from the stripper section 36 through a pair of compression rolls 56, 57 down a chute 58 and onto a take away conveyor 59 only a portion of which is shown.

In operation a folding machine 25 of the type illustrated is capable of folding 100 diapers per minute, or even more. The diaper blanks may be of various sizes but one preferred size is 12½ inches × 17½ inches. Thus, if the diaper blanks are disposed in end-to-end relation as they pass through a tape machine 30, the speed of the conveyor 37 would be 1,750 in/min. The speed of the conveyors 38, 48 however are faster, preferably 2,000 in/min in order to place the diaper blanks on 20-inch centers or, in other words, spaced 2½ inches apart. The folding boards 51 also are spaced on 20-inch centers and travel at 2,000 in/min since they register with and move in unison with the diaper blanks during the folding and tucking operations.

The folding bars 52 are likewise disposed on 18-inch centers but their movement is somewhat slower than the folding boards 51. The folding bars for example may be timed to move at 1,800 in/min in order to perform their initial folding operation. The picker pins 54 are spaced on 24-inch centers and since each pin carries a folded diaper 27 off its folding board 51 the picker pins travel at a speed of 2,400 in/min. Finally, to strip the diapers 27 from the picker pins 54, the stripper elements 55 are spaced on 30-inch centers and travel at a speed of 3,000 in/min in order to accommodate 100 diapers per minute.

RECEIVING AND SPEED-UP SECTION

As illustrated in FIG. 2, the preferred embodiment of the conveyor 38 includes three laterally spaced belts 61, 62, 63 which move in unison. The two edge belts 61, 63 are longer than the center belt 62 for reasons which will shortly appear. The edge belts travel around support rolls 64—66, drive roll 67 and belt tensioning rolls 68, 69 (see FIG. 1a). The drive roll 67 is driven by gear case 44 through a suitable timing chain or belt. The center belt travels around support rolls 64—66 and tensioning rolls 70, 71 and is driven by the edge belts. Each of the rolls 64—71 is journaled by bearings mounted on the frame of the folding machine 25.

The cooperating speedup conveyor 48 includes a pair of laterally spaced belts 72, 73 which are trained over pulleys 74 and 75 mounted respectively on a drive shaft 76 and an idle shaft 77. The bearings journaling the idle shaft are preferably adjustably mounted on the machine frame to permit belt tension adjustment. The drive shaft is also journaled in bearings mounted on the frame and is driven from gear case 49 through a suitable timing belt and pulley arrangement.

GLUE APPLYING SECTION

The glue guns 50 are mounted on the machine frame just downstream of the speedup belts 72, 73 and are laterally spaced to squirt through the space between the conveyor belts 61—63. The glue guns are of the conventional pneumatic

operated type and are mounted on adjustable gimbals 80 secured to the machine frame (see FIG. 3a). Control of the glue guns is through a photocell sensor 81, to be described, which actuates a conventional solenoid valve (not shown) in the pneumatic supply line to the guns. The amount of glue applied is regulated by a conventional timing relay coupled in series between the sensor and the glue guns. Preferably, the glue guns are of the heated, hot glue-circulating type which are well known in the art.

To prevent actuation of the glue guns 50 when there is no diaper blank 26 above the guns, another photocell sensor 82 is provided adjacent the glue guns and coupled in series with the sensor 81. The sensor 82 also includes a light source and photocell (not shown) which may both be located below the path of movement of the diaper blanks 26 on the conveyor 38. A mirror 83 positioned above the conveyor reflects light from the light source to the photocell of the sensor 82 and the sensor is arranged to open the control circuit for the sensor 81 when this occurs. In other words when the sensor 82 "sees" a light in the mirror 83 instead of a diaper, the glue guns 50 are rendered inactive.

INITIAL FOLDING SECTION

As mentioned above, the diaper blanks are preliminarily folded across a transverse fold line 26a. This is accomplished in the initial folding section 33 by the cooperative action of the folding boards 51 and folding bars 52. This sequence is shown in perspective in FIG. 5 and in side elevation in FIG. 6. Reference may also be made to the additional views of the folding boards in FIGS. 3, 7 and 9-11.

Each of the folding boards 51 is a composite structure made up of elements which include an upper triangular forming surface 90 and a lower triangular forming surface 91 having a centrally located slot 92. The upper and lower forming surfaces are secured to a transverse web member 94 which extends between a pair of end blocks 95. Each end block carries a pair of rollers 96 adapted to travel in a guide channel 97 (see FIGS. 5 and 7) secured to the machine frame. The rollers 96 are preferably journaled on shafts 98 having their inner ends bolted to the end blocks 95 and their outer ends secured by link brackets 99 to a roller chain 100 located on either side of the forming board 51.

The roller chains 100 are trained over an idle sprocket 101 (see FIGS. 1a and 3) and over a drive sprocket 102 (see FIGS. 1b and 18) mounted on shafts 103, 104 journaled in bearings on the machine frame. The shaft 103 for the idle sprocket 101 is preferably adjustably mounted to provide for adjusting the tension of the roller chain. The shaft 104 for the drive sprocket 102 is driven from gear case 45 by a suitable timing belt or chain. The folding boards 51 are thus moved about a closed loop 105 in the direction indicated by the arrows 106 in FIGS. 1a and 1b.

A substantial portion of the lower reach of the loop 105 is disposed parallel to and in close proximity to the conveyor belts 61, 63. Also the timing of the folding boards 51 is such that they are sequentially brought into engagement with the rear portion of the diaper blanks 26 on the belts 61, 63 after the blanks have been spaced apart by the speedup belts 72, 73. The left hand folding board 51 shown in FIG. 6 is in the position just described.

With further reference to FIG. 6, it will be seen that each of the folding bars 52 in the illustration machine 25 is carried about a continuous loop 109 defined by a pair of laterally spaced roller chains 110 trained about adjustable idle sprockets 111 and drive sprockets 112 mounted on shafts 113, 114 journaled in bearings on the machine frame. The drive shaft 114 is connected to gear case 43 through a suitable drive chain 115 and sprocket 116 (see FIG. 7).

In the preferred embodiment, each folding bar is of T-shaped construction with a leg 117 connected by a cross pin 118 to the roller chains 110. A leg brace 120 is also connected by a crosspin 121 to the roller chains 111 and to the leg 117

adjacent its midpoint by a bolt 122 to hold the folding bar 52 in outwardly and rearwardly inclined relation relative to the direction of chain movement as indicated by arrows 123.

The disposition of the loop 109 is such that the T-bar portion of the folding bars 52 follow a path which intersects the lower reach of the forming board loop 105 as the folding bars move along the upper reach of the loop 109. It will be noted that the folding bars are disposed centrally between conveyor belts 61, 63. Also, the movement of the folding bars is timed so that they each are positioned below and ahead of one of the folding boards 51 as they begin to travel along the upper reach of the loop 109. Then, due to the inclined disposition of the loop 109, each of the folding bars 52 engages the underside of one of the diaper blanks 26 and begins to lift it with respect to the leading edge of its folding board 51. In addition because of the slower movement of the folding bars 52 relative to the folding boards 51, the leading portion of the diaper blank is draped back over upper forming surface 90 of the folding board 51 (see FIGS. 5-7). This folding action is further assisted by upper edge guides 125 secured to the machine frame which press the (formerly leading portion of the) diaper blank 26 over the upper forming surface 90 of the folding board (see FIG. 5).

To prevent the folding board 51 from completely overtaking and interfering with the folding bar 52, the latter is quickly swung out of the path of the folding board. This is accomplished in the preferred embodiment by the increased forward component imparted to the folding bar as it travels around the end of the loop 109 defined by the drive sprockets 112 and due to the shortening of the distance between crosspins 118 and 121 as this takes place.

Before leaving the initial folding section 33 it should be noted that the sensor 81 for the glue guns 50 is located in this section of the illustrative folding machine 25. As seen in FIG. 6, the sprocket drive shaft 114 also drives a shaft 130 through a suitable timing belt or the like which is shown only schematically. Mounted on the shaft 130 is a disc 131 having a pair of apertures 132 cut in it (only one of which is shown). A photocell 133 is mounted on one side of the disc so that as the apertures 132 pass by the cell "sees" light from a light source 134 mounted on the other side of the disc in alignment with the cell. The signal from the photocell is then amplified and utilized to energize a solenoid valve in the pneumatic circuit of the glue guns 50 in a known manner.

Since the disc 131 is ultimately driven from the main drive motor 39 which also controls the speed movement of the diaper blanks 26 on the conveyor 38, rotation of the disc is maintained in timed relation to the movement of the diaper blanks. However, in order to precisely locate the glue spots relative to the transverse fold line 26a suitable adjusting means are desirably provided in the sensor mechanism. To this end, the photocell 133 and light 134 source are both mounted on a common bracket 136 rotatably mounted on an shaft 137 coaxial with the shaft 130. By rotating the bracket, application of the glue spots may be advanced or retarded relative to the center fold line 26a. Rotation of the shaft 137 is accomplished through a belt 138 trained around a pulley on the shaft 137 and another pulley on a control 139 shaft fitted with a knob 140. The distance between glue spots is fixed by the arcuate distance between apertures 132 in the disc 131. The amount of glue discharged by the guns 50 at each spot can be suitably controlled by a timer (not shown) in series with the sensor and the guns to control the "ontime" for the guns incident to each actuation.

SIDE TUCKING SECTION

In keeping with the invention the portions of the diaper blank located along the center fold line 26a outboard of the center 26b are interfolded to form a body-conforming diaper such as illustrated in FIG. 14. For this purpose the folding boards 51 are provided with additional forming elements including a pair of side tuckers 150 and a pair of intermediate

forming edges 151 located between the upper and lower forming surfaces 90, 91. As shown in FIG. 9, the forming edges 151 are defined by the forward edges of a pair of plates 152 and include a substantially straight line portion 151a which intersects the legs of the triangular forming surfaces 90, 91 at substantially a right angle and an arcuate outer portion 151b which extends outwardly from the surfaces 90, 91.

Each of the side tuckers 150 includes a forward forming arm 155 pivotally mounted on one of the end blocks 95. The forming arms are of doubled back configuration adapted to swing around the plates 152 and between forming surfaces 90, 91. Each side tucker 150 also includes an operating arm 156 which carries a cam follower 157 adapted to ride along a cam surface 158 secured to the machine frame and a return arm 159. A spring 160 connected between the return arms of a pair of the side tuckers 150 for each folding board 51 normally biases the cam followers 157 against the cam surface 158.

After the diaper blanks 26 are preliminarily folded over the folding boards 51 by the folding boards 52 in the initial folding section 33, the blanks are carried on the folding boards into the side-tucking section 34. Referring to FIG. 12, the folding boards 51 are moved from left to right by the roller chains 100. As the followers 157 engage the cams 158, the tucking arms 155 are swung inwardly engaging the material of the diaper blank along the center fold line 26a on either side of the center 26b. The progressive inward movement of the tucking arms 155 interfolds the material of the diaper blank initially lying outboard of the center between the upper and lower forming surfaces 90, 91 and over the intermediate forming edges 151.

Completion of the side-tucking and interfolding operation occurs when the tucking arms 155 reach the position illustrated in FIG. 13 and the corresponding location in FIG. 12. At this point the tucking arms 155 have been swung to their inner most positions by the cams 158 and the followers 157 on the actuating arms 156. With the tucking arms in this position, the diaper is firmly folded under the legs of the triangular shaped upper and lower forming surfaces 90, 91 along diagonal fold lines 27a and 27b, respectively. In addition, the material of the diaper blank initially lying along the center fold line 26a adjacent the edges of the blank has been drawn over the arcuate portion 151b of the intermediate forming edge 151 and is folded over the straight edge portion 151a of the intermediate forming edge. This results in reversely interfolding each side of the diaper blank 26 along crease lines 27c and 27d to form the leg engaging portions D.

Once the diaper blank 26 has moved into the side-tucking section 34 it is no longer supported by the conveyor belts 61, 63 (seen in phantom at the left of FIG. 12). Instead the underside of the diapers are supported by a flat upper surface 161 of the cam 158 and the upper side of the diapers are engaged by a holddown bar 163 located above the path of the folding boards 51. The sliding friction between the diaper blank and the holddown bar 163 and plate surface 161 keep the blank tautly stretched over the upper and lower forming surfaces 90, 91. It will also be understood that the final location of the inner tips of the tucking arms 155 is such that sharp crease lines 27c and 27d are formed in the blank without necessitating engagement of the tucking arms along the entire length of these crease lines. Indeed, in the preferred embodiment, the tucking arms are relieved inwardly of their tips in order to avoid engagement of the tucking arms with the previously applied glue spots.

Upon completion of the side tucking operation the tucking arms 155 are swung out of engagement with the interfolded diaper by the biasing force of the spring 160 as the cam followers 157 move inwardly on the receding cam track 158. The folded diaper 27, is however, retained on the folding board 51.

PICKOFF SECTION

FIGS. 15a—21 illustrate the details of the picker pins 54 in the pickoff section 35, as well as further details of the loop 105

of the folding boards 51 and details of the stripping and discharge section 36. Each of the picker pins 54 is of substantially L-shaped configuration with its long leg projecting forwardly in the direction of picker pin travel indicated by arrows 165. The short leg of each picker pin 54 is bolted to a bracket 166 mounted on a pair of cross pins 167, 168 secured at their ends by links 169 forming part of a roller chain 170 on each side of the pin 54.

Each of the chains 170 is trained over a drive sprocket 171, a return sprocket 172 and an idle sprocket 173 mounted on shafts 174—176 journaled in bearings secured to the machine frame. The drive shaft 174 and drive sprockets 171 are driven from gear case 46 by a suitable timing belt or chain and the bearing for the return shaft 175 are preferably adjustably mounted on the machine frame to control the chain tension. The upper and lower reaches of chain travel are also preferably supported by guide surfaces 177, 178 secured to the machine frame.

As seen in FIG. 15a, the path of travel of the picker pins 54 between the return sprockets 172 and idle sprockets 173 is inclined upwardly from below the folding boards 51 such that the picker pin path intersects the folding board path at an acute angle. The picker pins are centrally located between the roller chains 170 and are timed to rise between adjacent ones of the folding boards 51. From this point, the picker pins, due to their faster movement, advance through the slot 92 in the lower forming surface 91 of the folding board engaging the folded diaper 27 and carrying it off the folding board. This sequence is illustrated in FIGS. 15a, 15b and 18 and it will be seen that the diaper is completely removed from the folding board prior to the folding board being carried up and around sprockets 102 by the roller chains (see FIGS. 18 and 19). To insure that the diapers stay on the picker pins as the folding boards are lifted away the sprockets 102 also carry web members 180 having depending feet 181 which engage the diapers.

STRIPPING AND DISCHARGE SECTION

As the diapers move past sprocket wheels 102 on the picker pins 54, they also move off the upper supporting surface 161 of the cams 158 and between guide surfaces 182 and 183 secured to the machine frame (see FIGS. 18, 20 and 21). The stripping elements 55, in this case a pair of laterally spaced pins, are mounted on cross pins 185 which are secured at their ends by links 186 forming part of roller chains 187 on each side of the stripping elements. These chains 187 are trained about drive sprockets 188 and adjustable return sprockets 189 such that the lower reach of the chain is located parallel to and just above the upper reach of the chains 170. The drive sprockets 188 are mounted on a drive shaft 190 journaled in bearings secured to the machine frame and driven through a suitable timing chain from gear case 47. Due to their faster speed the stripping elements 55 overtake and straddle the picker pins 54 and carry the diapers 27 forwardly off the picker pins.

Adjacent the drive sprockets 188 the diaper is discharged onto a short transfer conveyor 191 and then between compression rolls 56, 57. The transfer conveyor 191 and the rolls 56, 57 are driven from drive shaft 190 by a suitable chain and sprocket arrangement such as shown in dash lines in FIG. 20. The compression rolls 56, 57 not only serve to flatten the pre-folded diapers somewhat thereby creasing the fold lines but also help to insure good contact between the interfolded areas of the diaper and the spots of adhesive (see FIG. 21). The folded diapers 27 are then discharged down chute 58 and onto conveyor 59 for delivery to suitable packaging equipment (not shown).

While the invention has been described herein in connection with certain preferred methods and apparatus we do not intend to limit the invention to the specific procedures described or embodiments shown. On the contrary, we intend to cover such alternative and equivalent methods and apparatus as fall within the spirit and scope of the appended claims.

We claim:

1. The method of folding disposable diaper blanks into substantially infant-conforming configuration comprising the steps of:

conveying the diaper blanks in spaced-apart, end-to-end relation along a predetermined flow path;
bringing a folding board into registry with the rear half of each diaper blank as it moves along said flow path;
intercepting the leading portion of each diaper from below with a rearwardly inclined folding bar moving at a speed slower than the diaper to lift said leading portion and preliminarily folding it over the folding board along a medially located transverse fold line; and
engaging the portions of the diaper located along said transverse fold line on each side of the center thereof with a side tucking element to interfold said portions between the upper and lower surfaces of the preliminarily folded diaper while reversely interfolding between said portions the part of the diaper located along said transverse fold line most distant from the center thereof.

2. The method defined in claim 1 including the preliminary step of applying controlled quantities of adhesive to the underside of the diaper blank at such locations as to be subsequently enclosed between interfolded layers of the diaper.

3. The method defined in claim 1 including the intermediate step of withdrawing the folding bar from the preliminarily folded diaper blank by accelerating the bar down and away from the folding board before the folding bar is overtaken by the folding board.

4. The method defined in claim 1 including the intermediate step of frictionally engaging the upper and lower surfaces of the preliminarily folded diaper blank to keep the blank substantially tautly stretched over the folding board during the side tucking and interfolding operation.

5. The method defined in claim 1 including the step of actuating said side tucking elements with an elongated cam track which is effective to swing said elements into engagement with said portions of the diaper to be interfolded.

6. The method defined in claim 5 wherein each of said side tucking elements includes a cam follower and said cam followers are biased into engagement with said elongated cam track.

7. The method defined in claim 1 including the further step of picking each of the folded diapers from the folding boards with a picking element traveling at a speed greater than that of the folding board.

8. The method defined in claim 7 including the additional step of stripping the folded diapers from the picking element with a stripping element traveling at a speed greater than that of the picking element.

9. The method defined in claim 2 including the further step of compressing the folded diapers in order to crease the fold lines and insure good contact of the adhesive with the interfolded layers of the diaper.

10. The method defined in claim 1 wherein a plurality of the folding boards are moved along a closed loop disposed in part parallel to and in close proximity to said flow path.

11. The method defined in claim 1 wherein a plurality of said folding bars are moved along a closed loop disposed in part to intersect said flow path from below at an acute angle.

12. The method defined in claim 7 wherein a plurality of said picking elements are moved along a closed loop disposed in part to intersect and then move along said flow path.

13. The method defined in claim 8 wherein a plurality of said stripping elements are moved along a closed loop disposed in part parallel to and in close proximity to said flow path.

14. The method defined in claim 7 wherein said picking element is advanced through a slot located in the lower surface of said folding board along the longitudinal center line thereof.

15. The method defined in claim 8 wherein said stripping element is advanced past said picking element with portions of said stripping element straddling said picking element and engaging the rear edge of the folded diaper.

16. Apparatus for folding precut diaper blanks traveling in spaced-apart relation and timed sequence along a predetermined flow path comprising, in combination:

a folding board mounted for continuous movement along a first loop disposed in part parallel to and in close proximity above said flow path;

means for moving said folding board in timed sequence with said blanks so that the under side of said folding board periodically engages the trailing portion of respective ones of said blanks and moves in unison therewith;

a rearwardly inclined folding bar mounted for continuous movement along a second loop disposed in part to intersect said flow path from below at an acute angle; and

means for moving said folding bar in timed sequence with said blanks but at a lower rate of speed so that said folding bar periodically engages and progressively lifts and folds the leading portion of respective ones of said blanks over the upper surface of said folding board along a medially located transverse fold line as said folding bar moves from below and ahead to above and behind the forward portion of said folding board.

17. Folding apparatus as defined in claim 16 including means for forwardly swinging said folding bar down and away from said folding board and out of engagement with said folded blank.

18. Folding apparatus as defined in claim 17 including guide means located in close proximity to said flow path downstream of said intersection for engaging and holding said folded blank over said folding board as said folding bar is swung away.

19. Folding apparatus as defined in claim 16 wherein said folding board is of generally triangular shape with the apex thereof forming the leading edge and said folding bar includes an element extending substantially transverse to said flow path for folding said blank over said apex.

20. Folding apparatus as defined in claim 16 wherein said folding board includes a pair of spaced-apart forming surfaces of generally triangular shape with aligned forwardly projecting apices and rearwardly diverging legs and an intermediate forming element between said surfaces having interiorly facing edge portions extending outwardly substantially at right angles to said legs and means for tucking the preliminarily folded edge of said blank outboard of said apices so as to interfold the material thereof over said legs and edges and between said forming surfaces.

21. Folding apparatus as defined in claim 20 wherein said tucking means includes a element on each side of said folding board swingable between said forming surfaces and around said forming edge.

22. Folding apparatus as defined in claim 21 wherein each of said swingable elements carries an operating arm fitted with a cam follower and said cam followers are biased into engagement with an elongated cam track shaped to first progressively swing said elements toward each other from opposite sides of the folding board and then swing said elements away from each other.

23. Folding apparatus as defined in claim 20 wherein said forming surfaces are substantially horizontally disposed as said blank is interfolded, the lower one of said forming surfaces being slotted along its longitudinal center line to receive a picking pin and means are provided for moving said picking pin through said slot to remove said folded diaper from said folding board.

24. Folding apparatus as defined in claim 23 including a plurality of forming boards and a plurality of picking pins mounted for movement in timed sequence with said folding boards but at a faster speed, in order to pick said diapers from said folding boards as said picking pins advance successively through said slots.

25. Folding apparatus as defined in claim 24 including a plurality of stripping elements mounted for movement along a closed loop in part parallel to and in close proximity with said picking elements but at a faster speed in order to strip said diapers from said picking elements.

26. Apparatus for folding precut diaper blanks comprising, in combination:

a forming board including elements defining a transverse fold line about which said blank is preliminarily folded; said forming board also including elements defining a pair of spaced-apart and generally parallel forming edges having substantially triangular configurations with outwardly projecting apices;

said forming board including further elements defining intermediate forming edges lying between said spaced triangular forming edges and extending substantially perpendicularly inwardly therefrom; and

tucking means engageable with said blank at a pair of points spaced along said transverse fold line on opposite sides of said apices and between said intermediate forming edges for diagonally interfolding the side portions of the diaper between said spaced triangular forming edges and reversely interfolding the marginal diaper material over said intermediate forming edges.

27. Apparatus as defined in claim 26 wherein said forming

board is mounted for movement along a flow path on which said diaper blanks are preliminarily deposited in spaced-apart relation and in timed sequence to register with the trailing portion thereof and including a moving folding bar mounted for movement along a path which intersects said flow path and in timed sequence to intercept the leading edge of said diaper blanks for preliminarily folding said diaper over said folding board.

28. Apparatus as defined in claim 27 wherein said tucking means includes a element on each side of said folding board swingable between said forming surfaces and around said forming edge.

29. Apparatus as defined in claim 28 wherein each of said swingable elements carries an operating arm fitted with a cam follower and said cam followers are biased into engagement with an elongated cam track shaped to first progressively swing said elements toward each other from opposite sides of the folding board and then swing said elements away from each other.

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