

Nov. 15, 1966

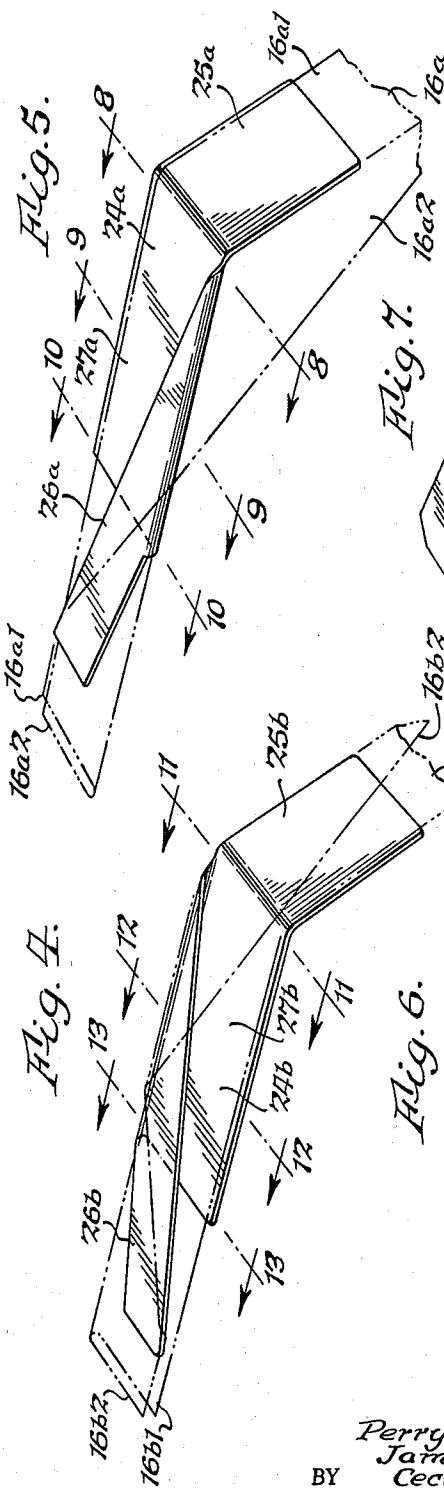
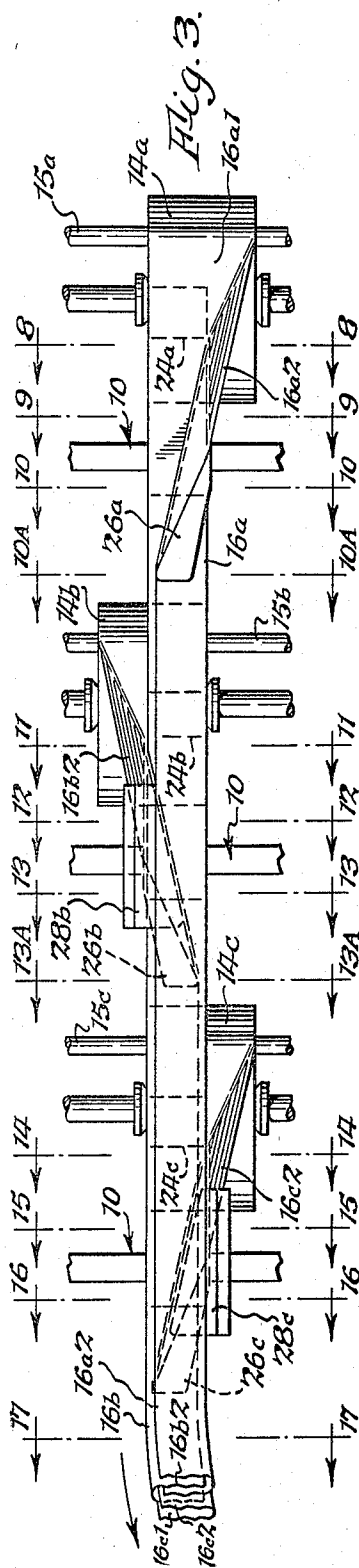
P. O. PHERSON ET AL

3,285,599

WEB FOLDING MACHINE

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20 Sheets-Sheet 2



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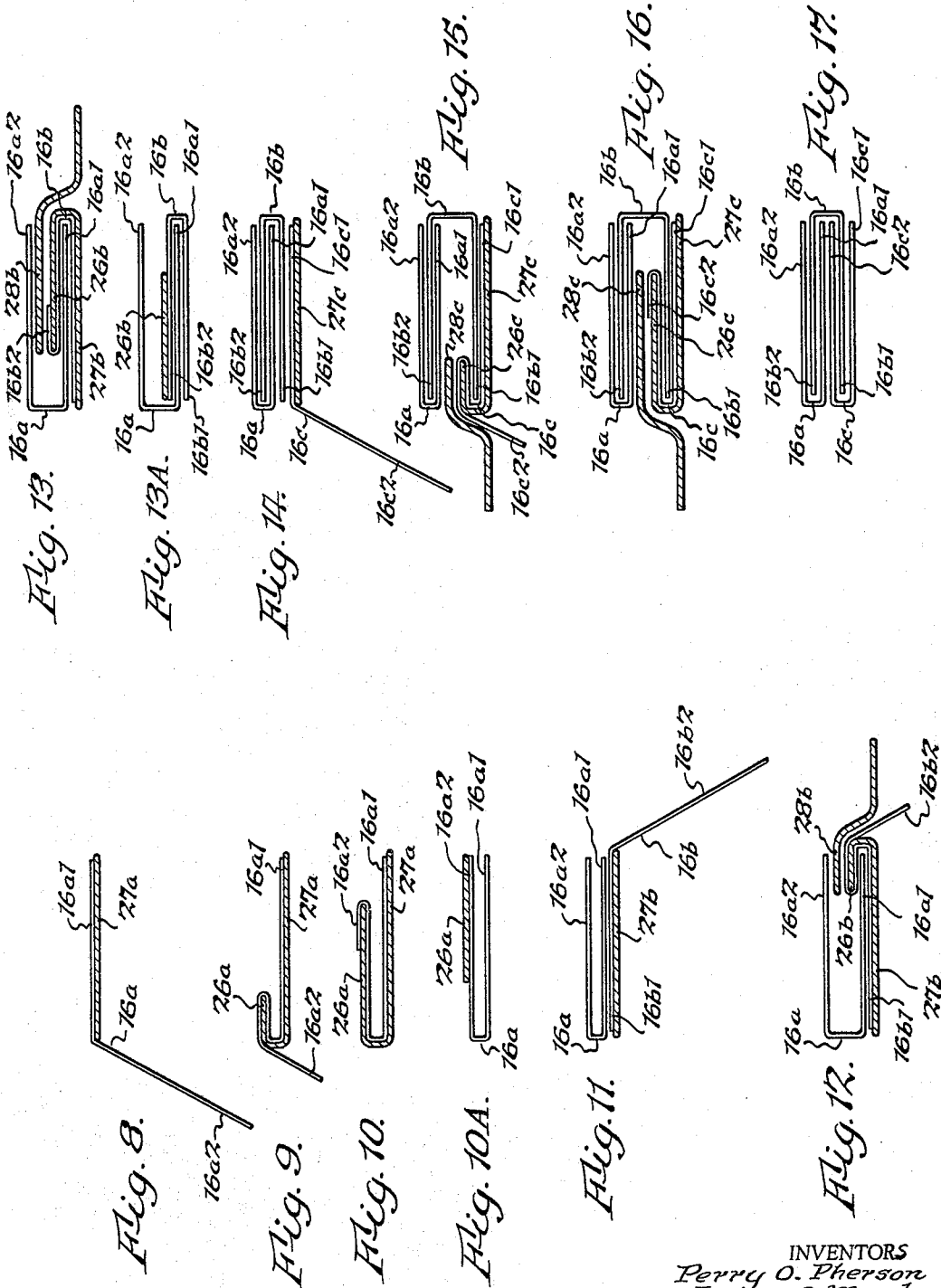
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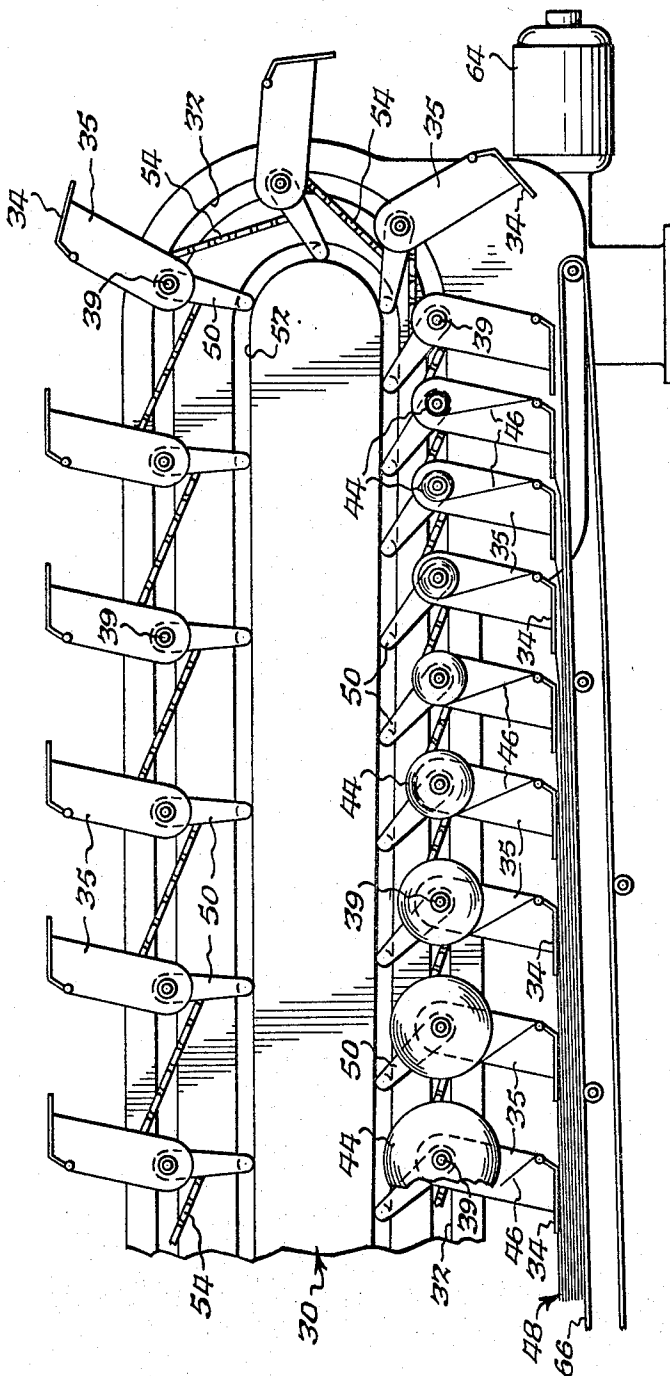


Fig. 19.

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Fig. 20.

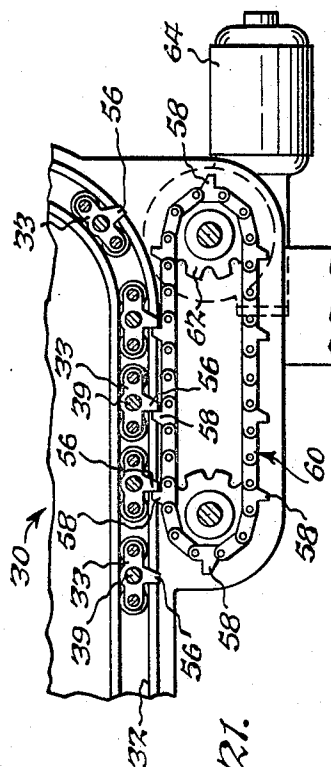
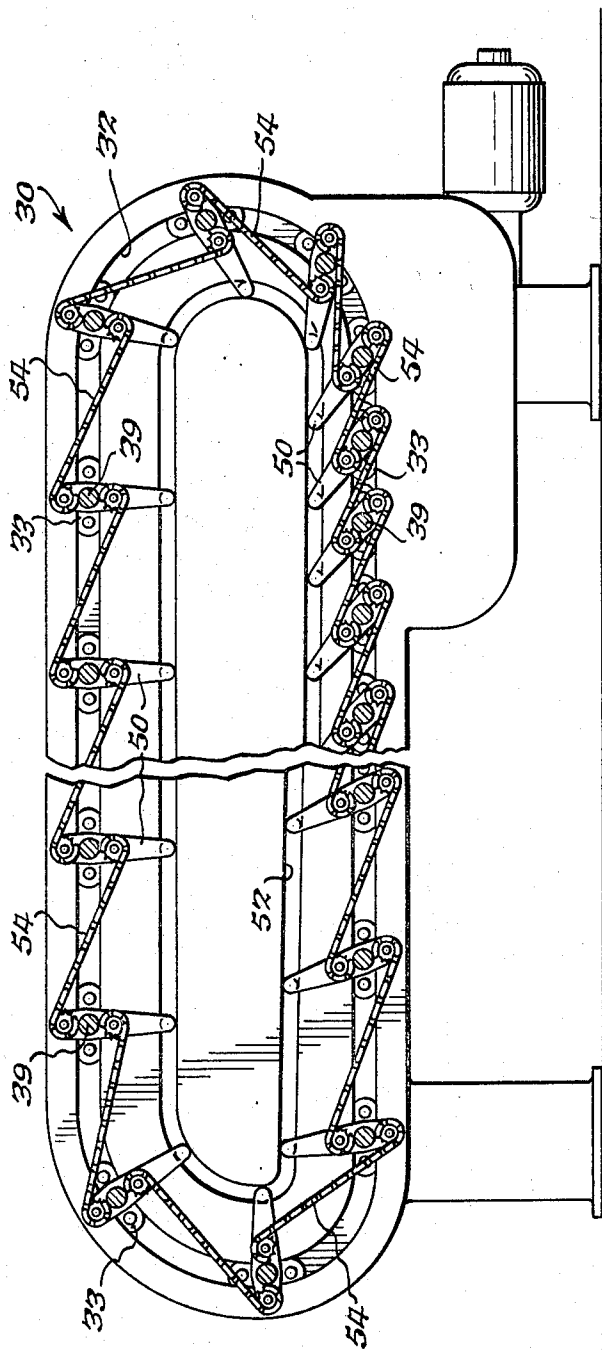


Fig. 21.

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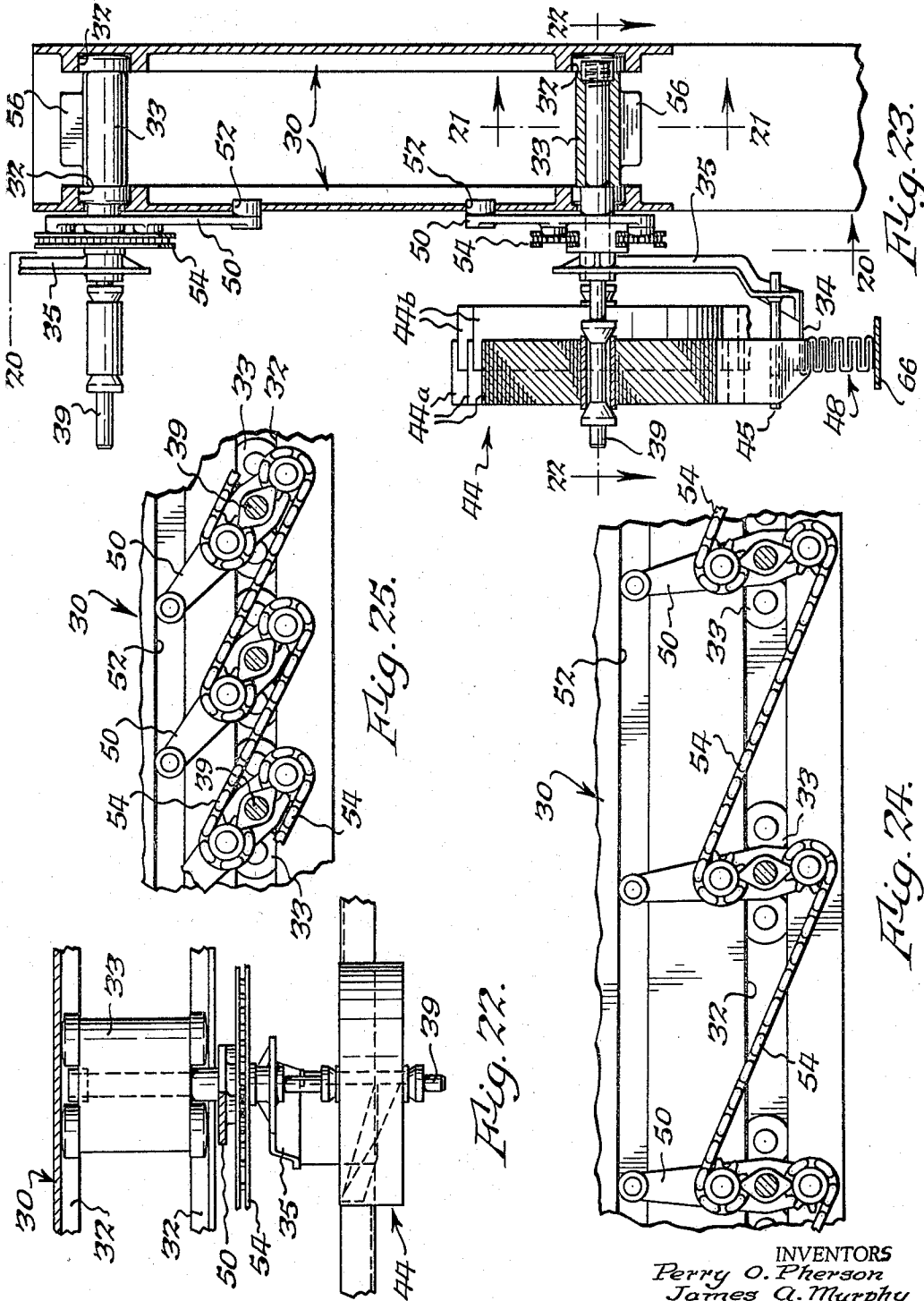
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WEB FOLDING MACHINE

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20 Sheets-Sheet 7



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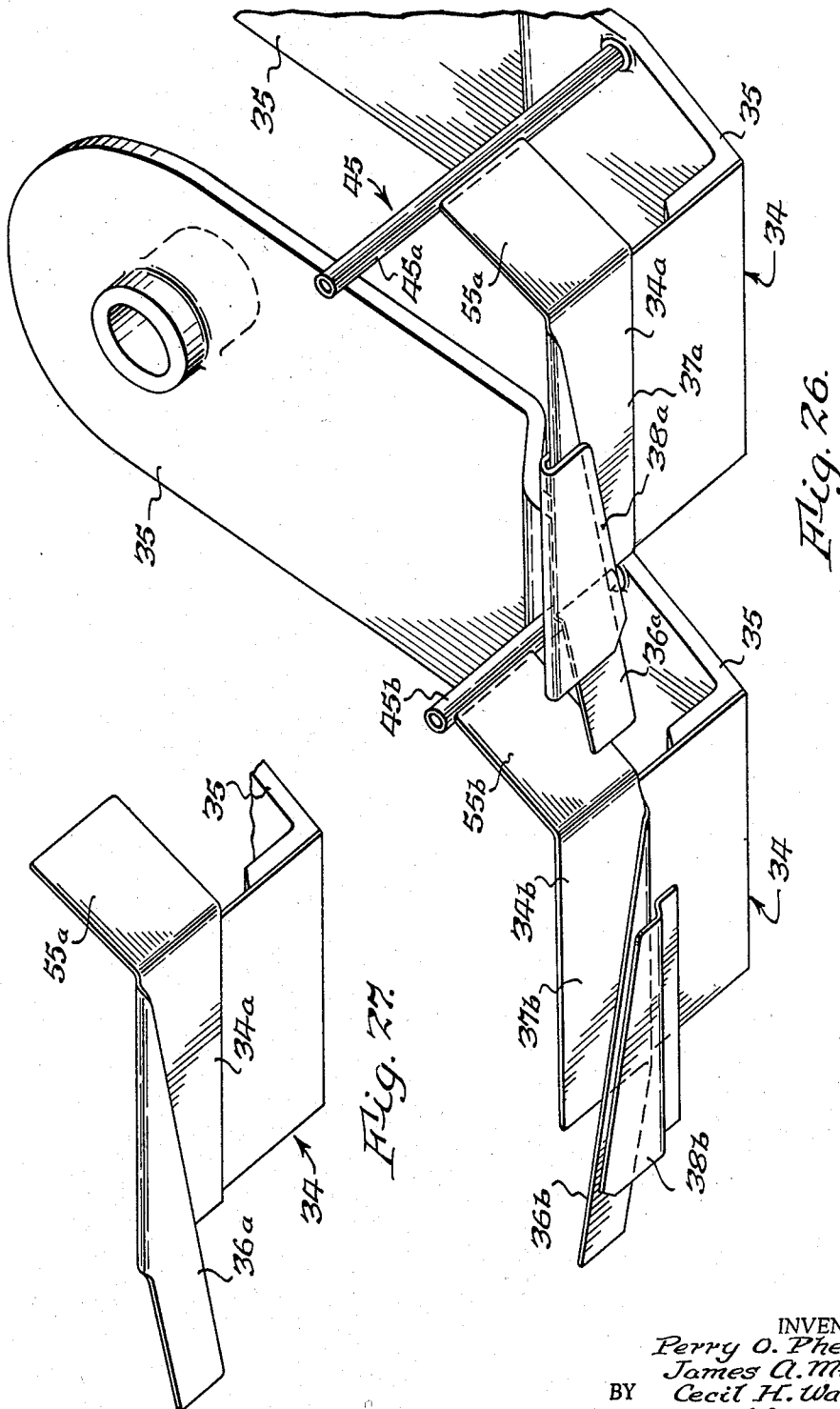
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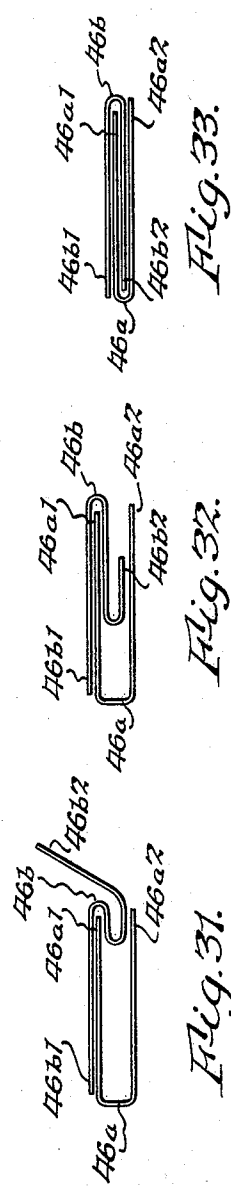
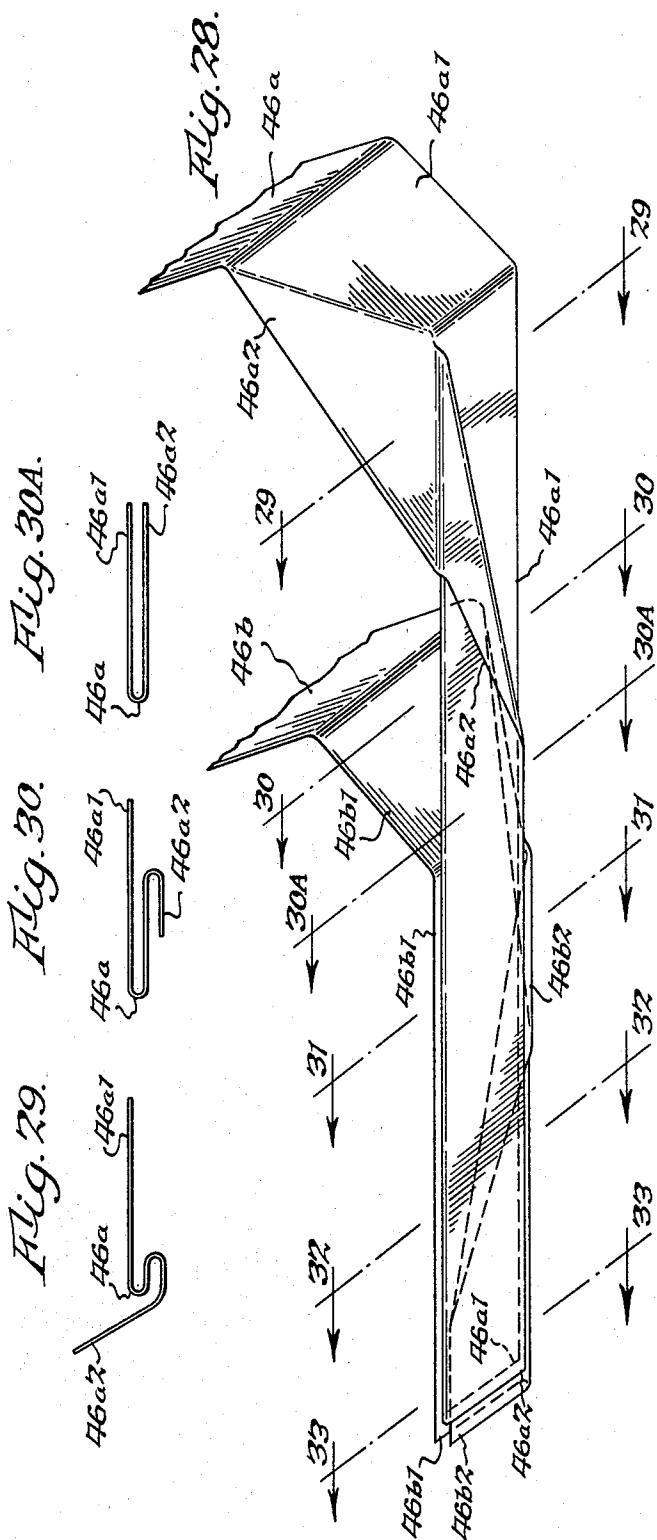
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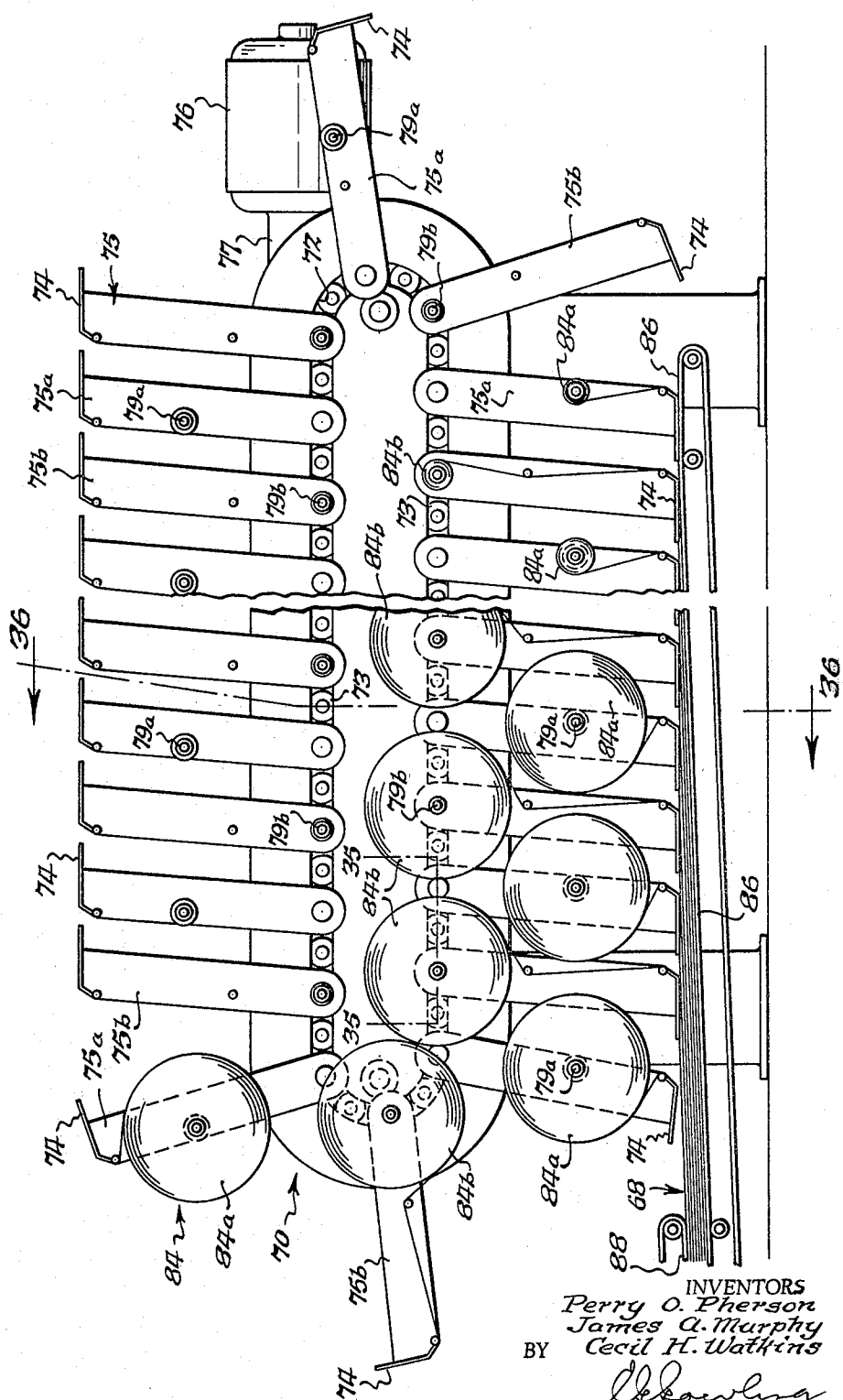
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Fig. 34.



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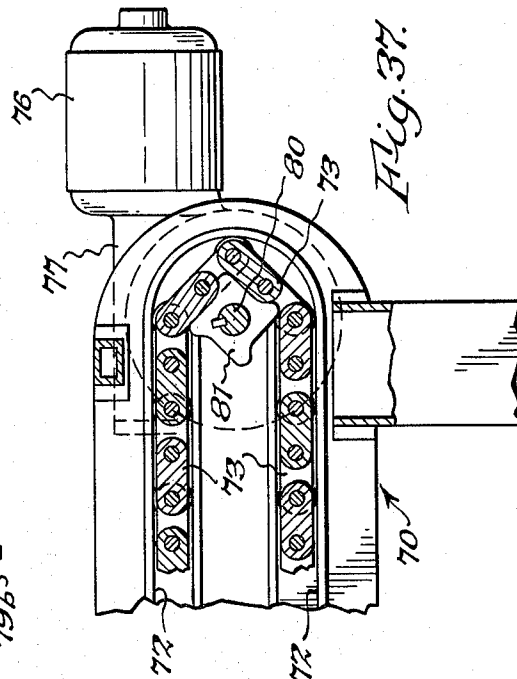
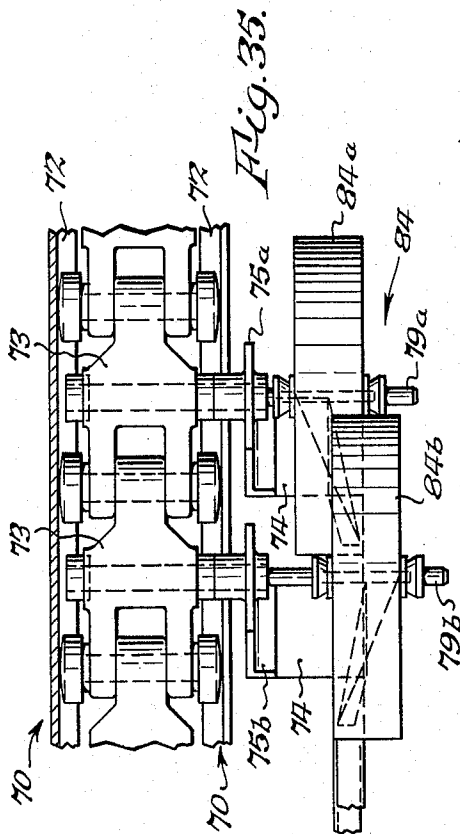
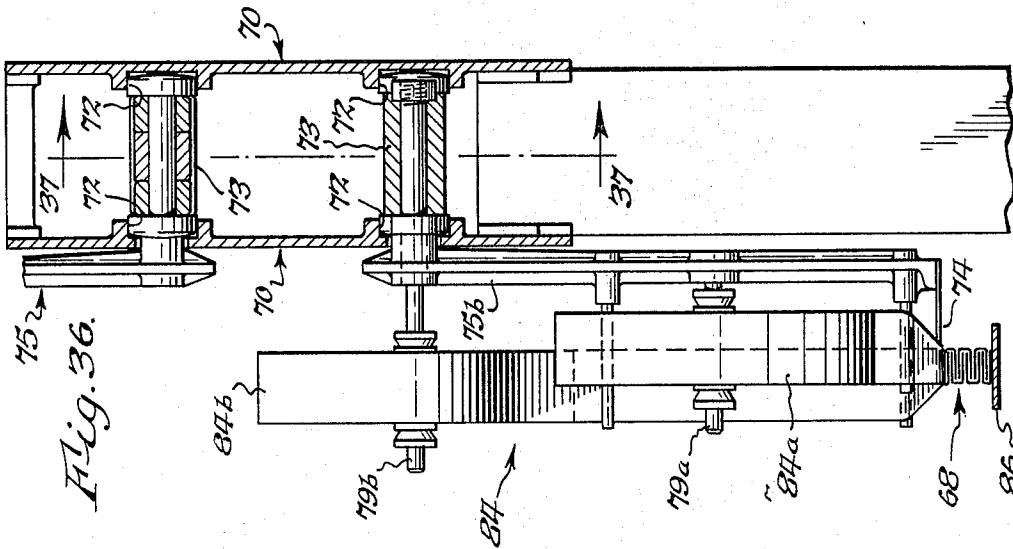
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Fig. 38.

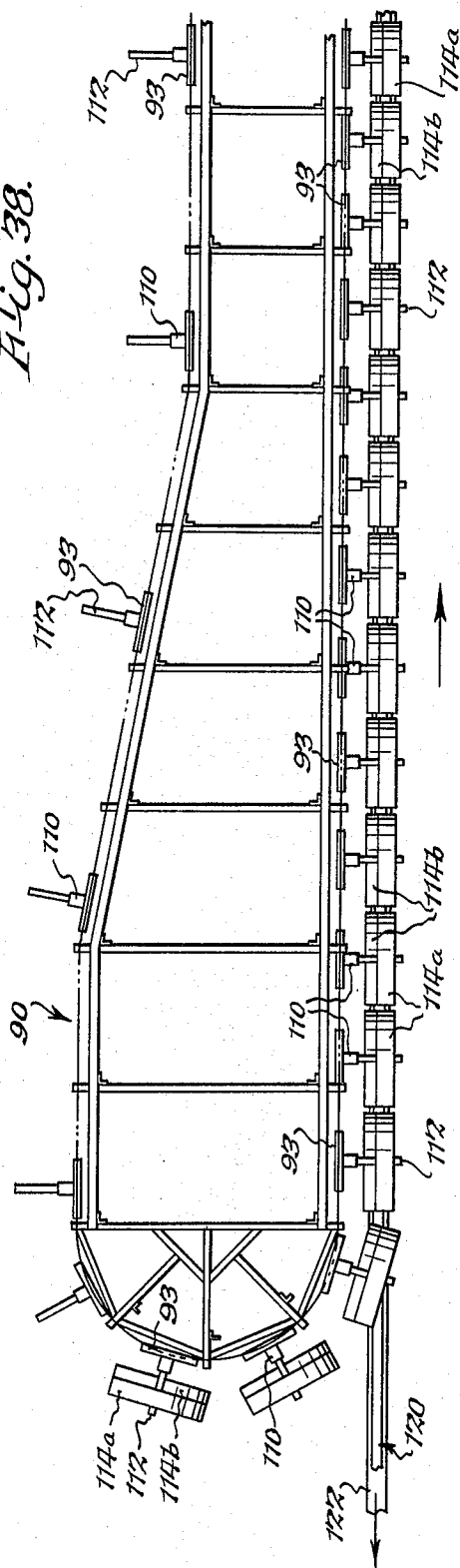
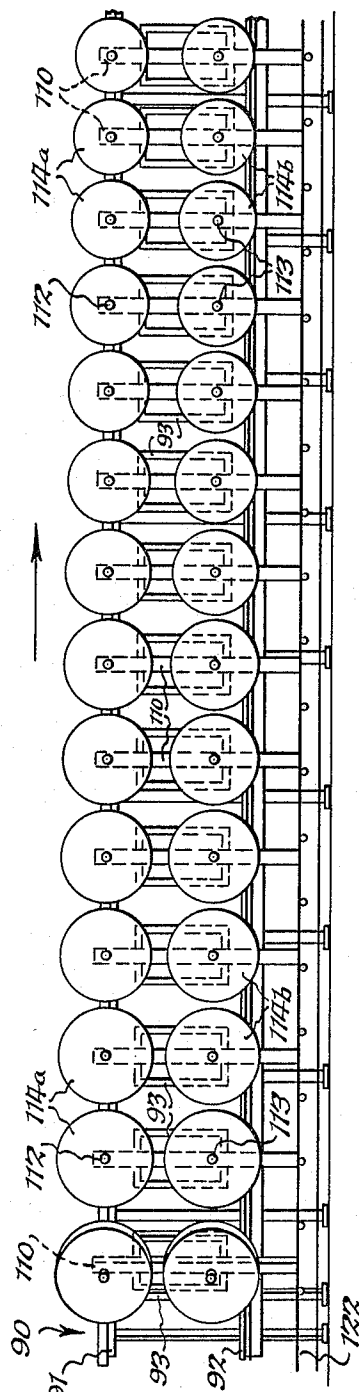


Fig. 40.



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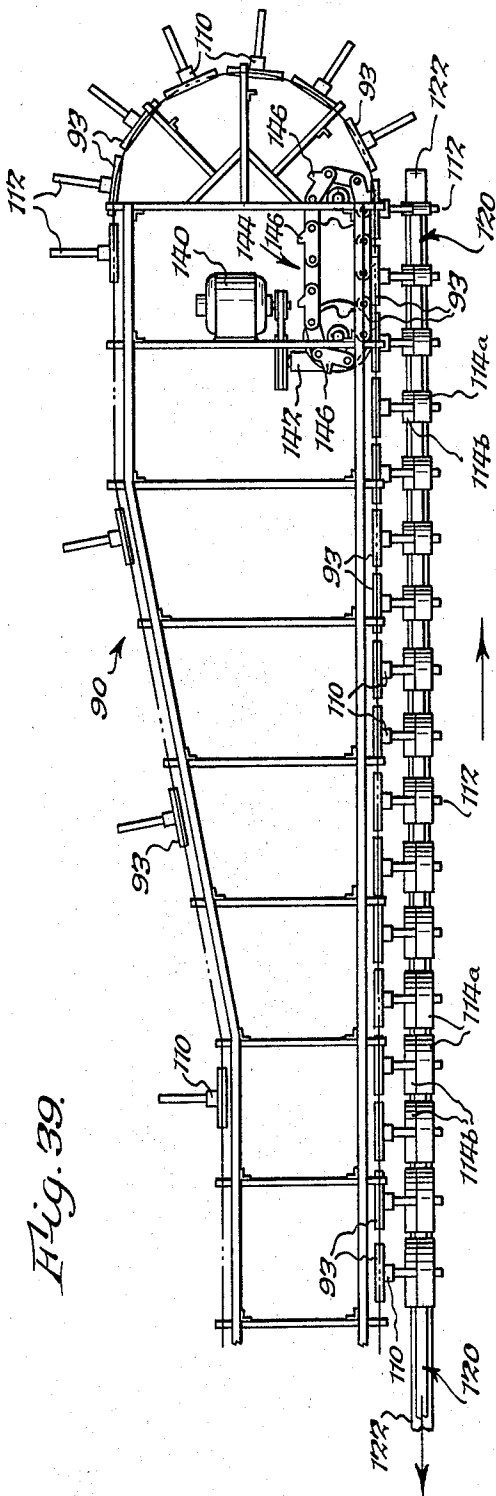
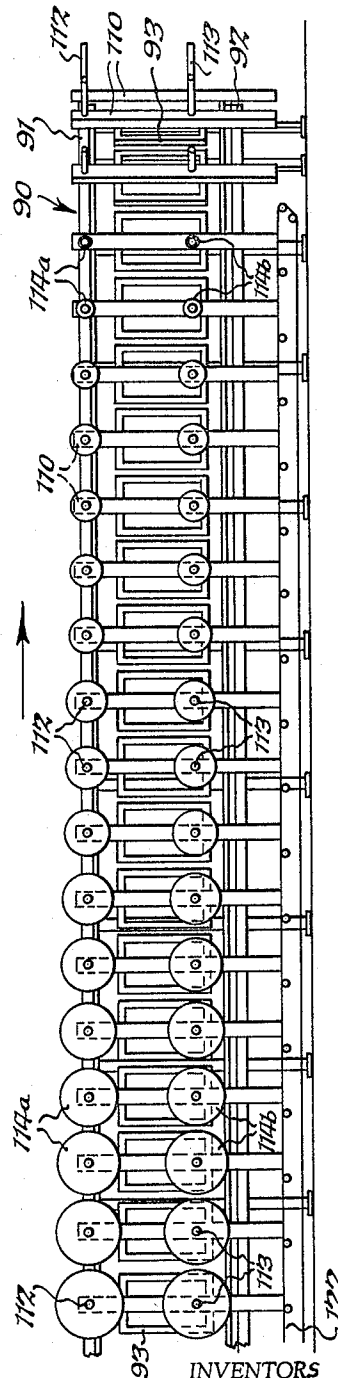


Fig. 41.



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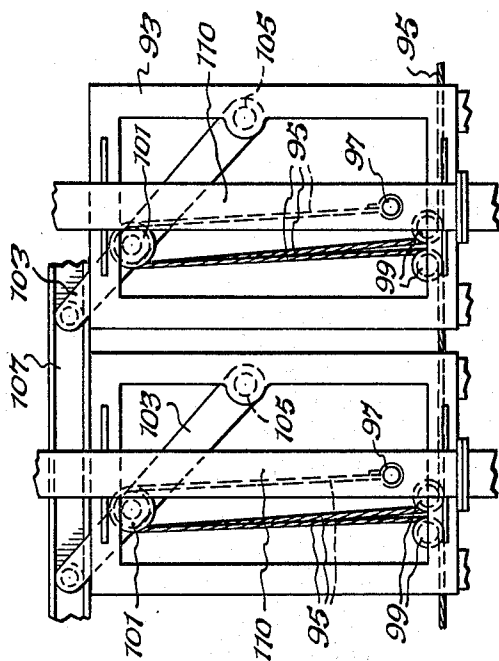


Fig. 42.

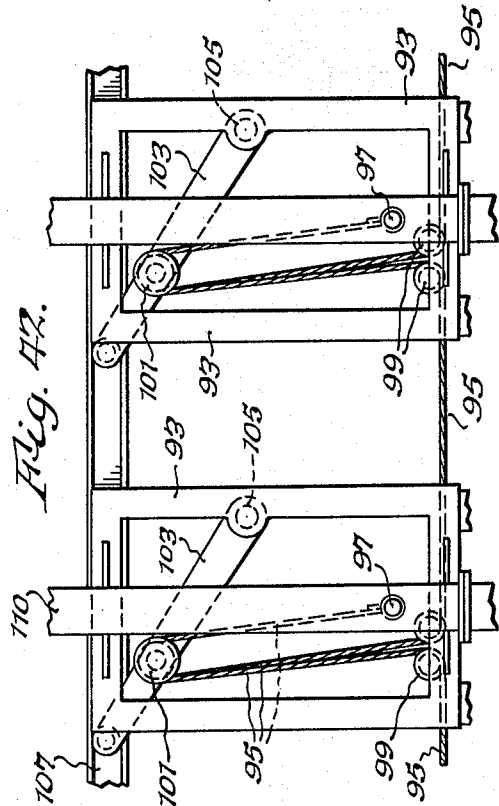


Fig. 43.

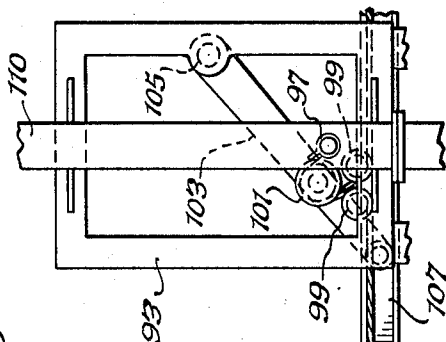
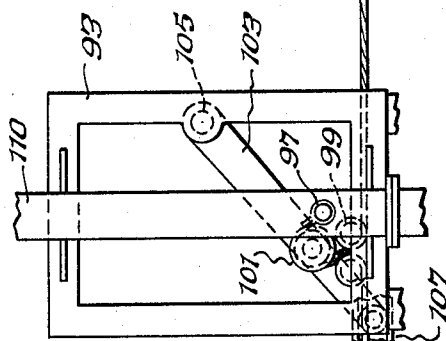


Fig. 44.



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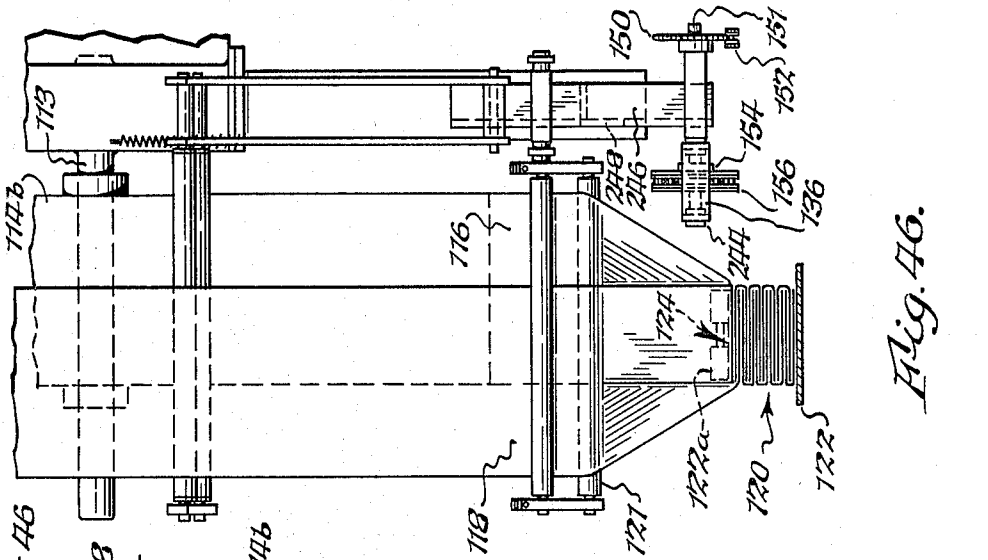


Fig. 46.

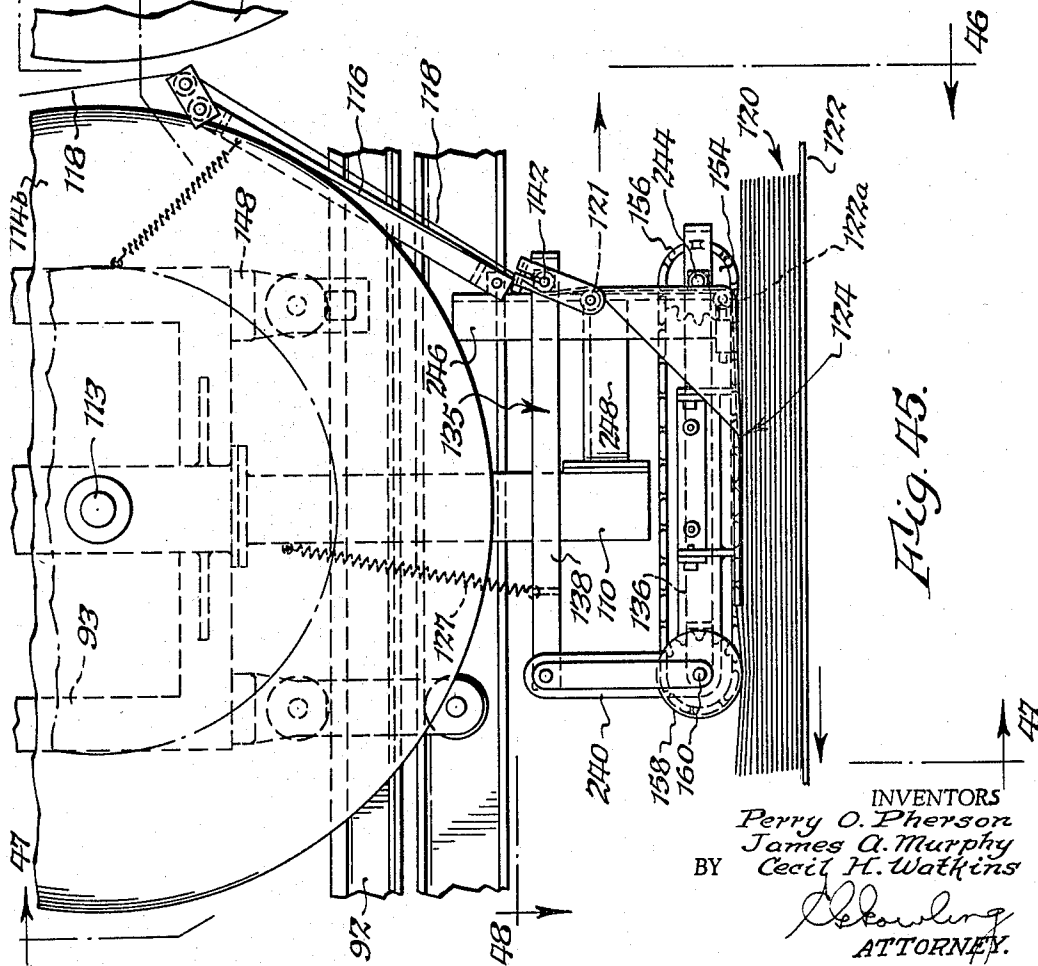


Fig. 45.

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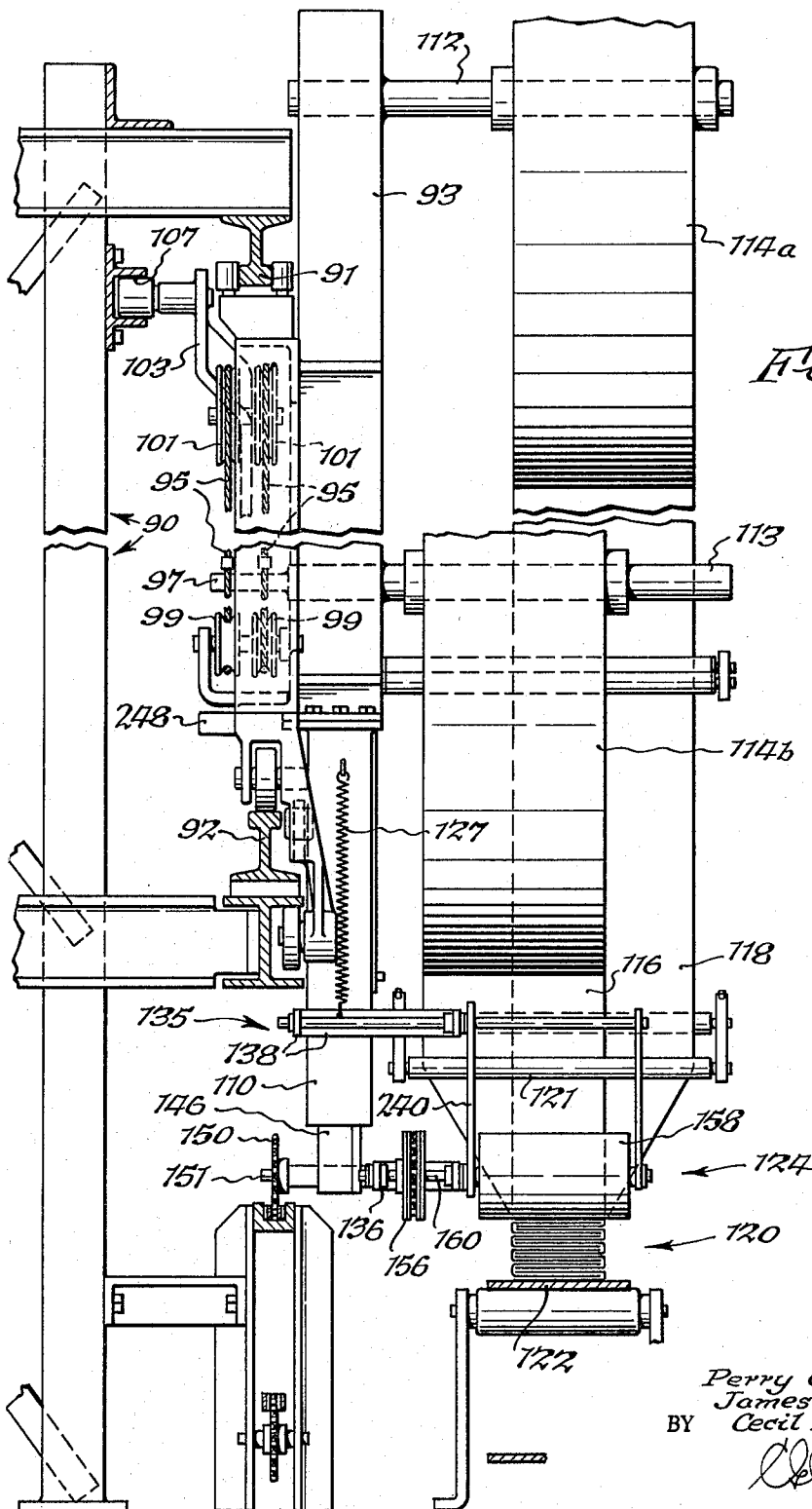


Fig. 47.

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Fig. 78.

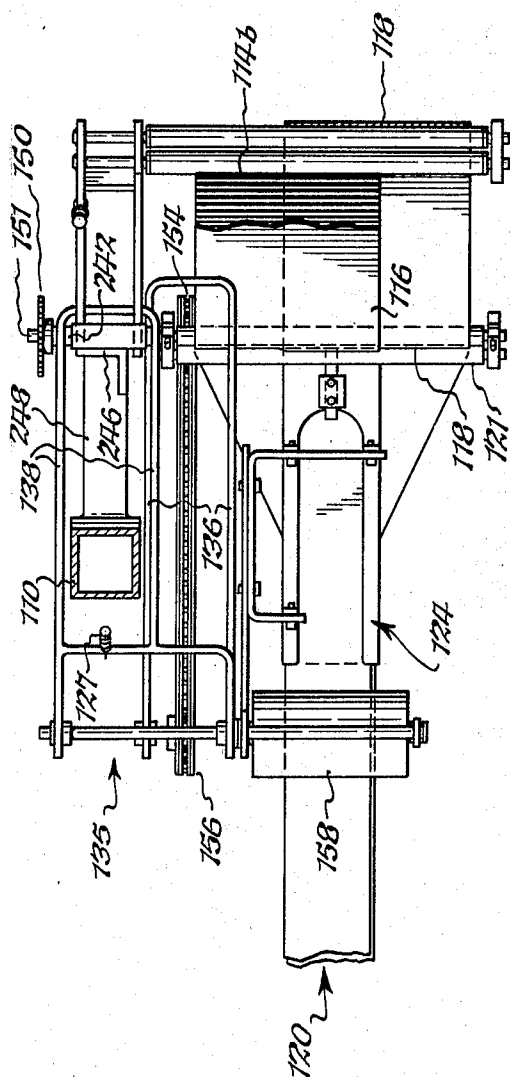
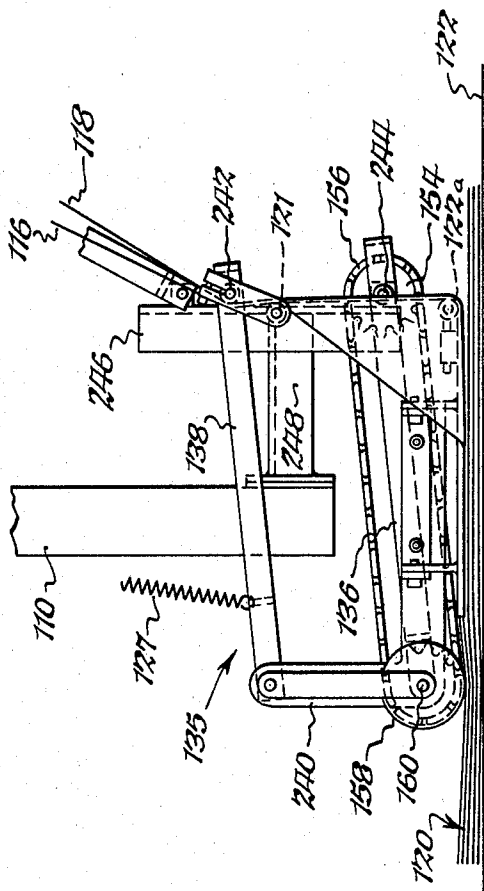


Fig. 79.



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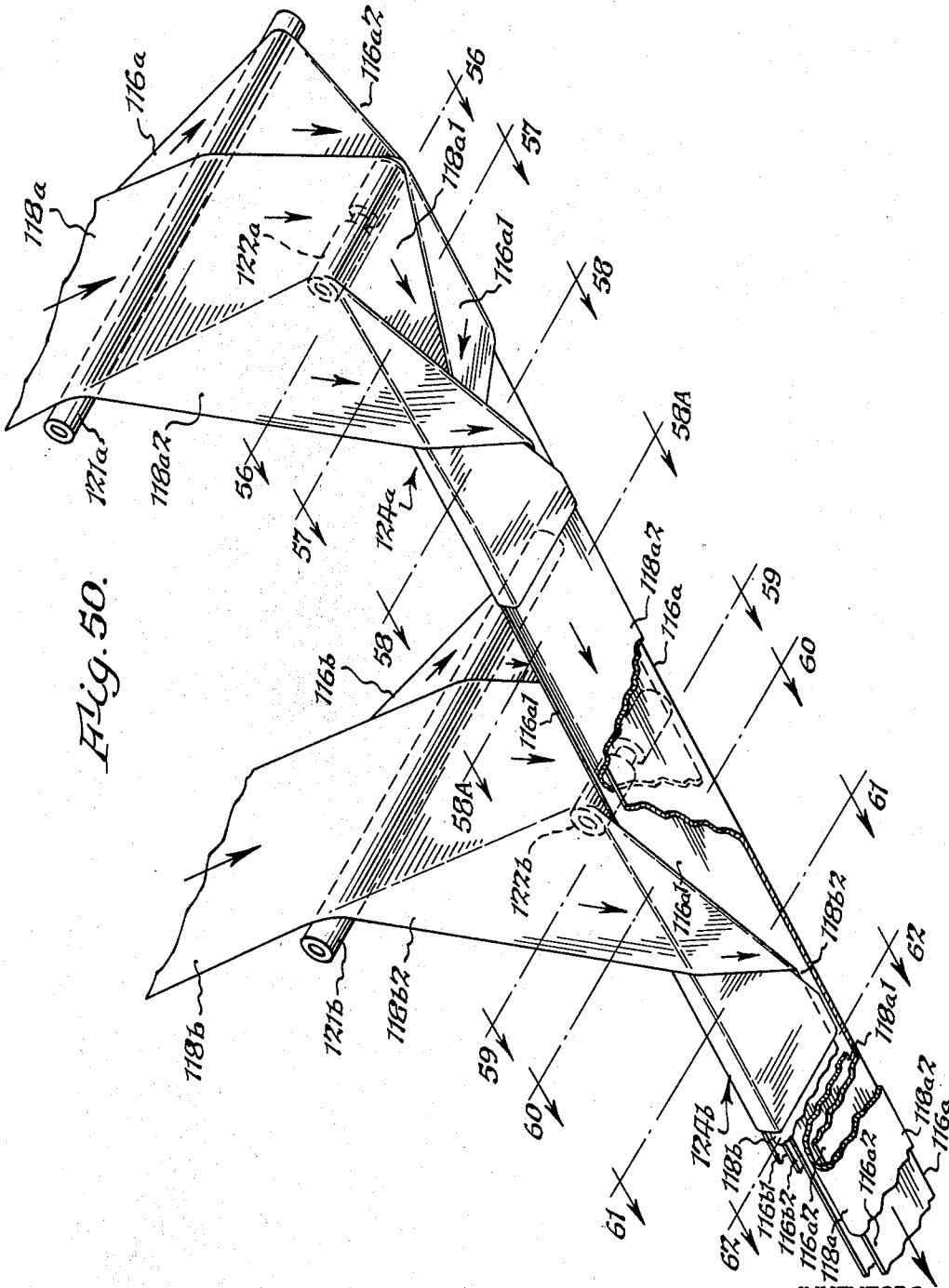
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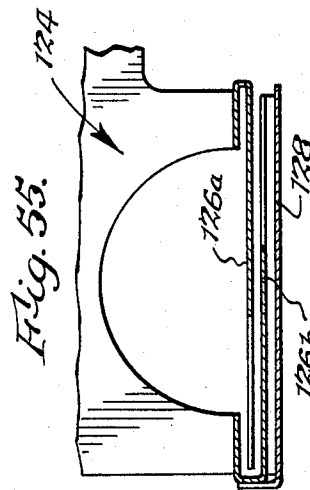
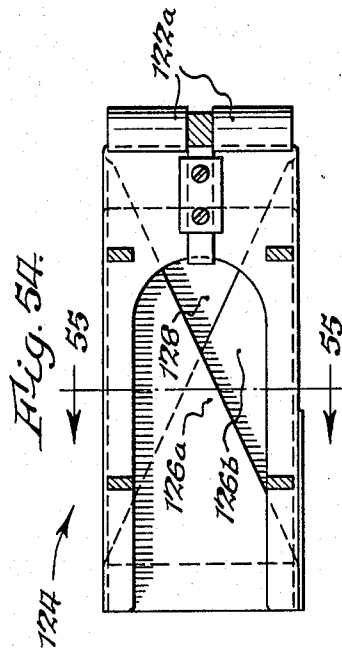
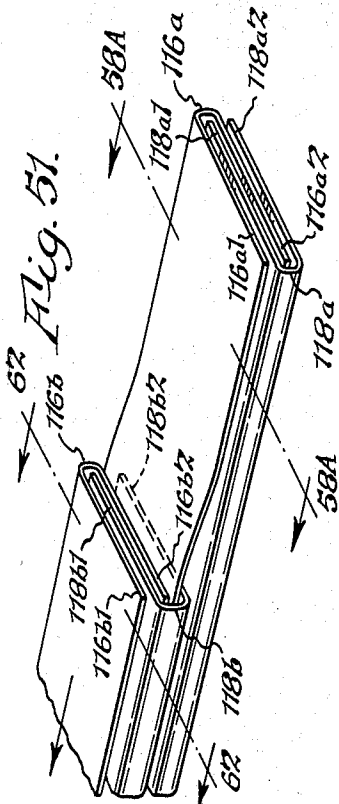
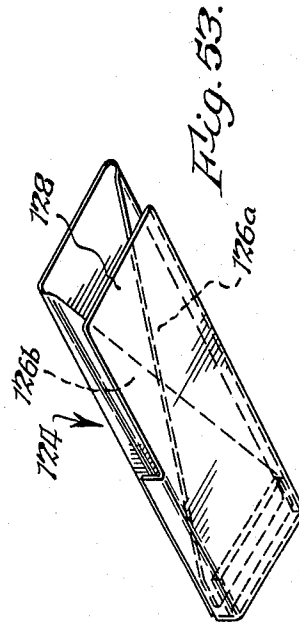
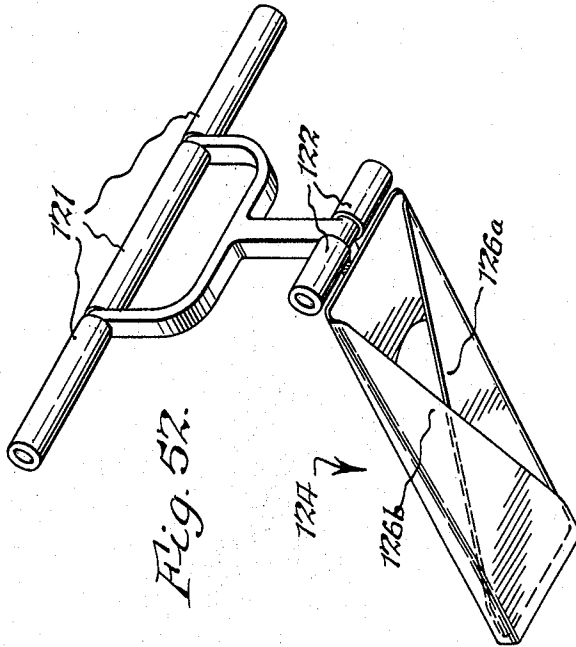
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WEB FOLDING MACHINE

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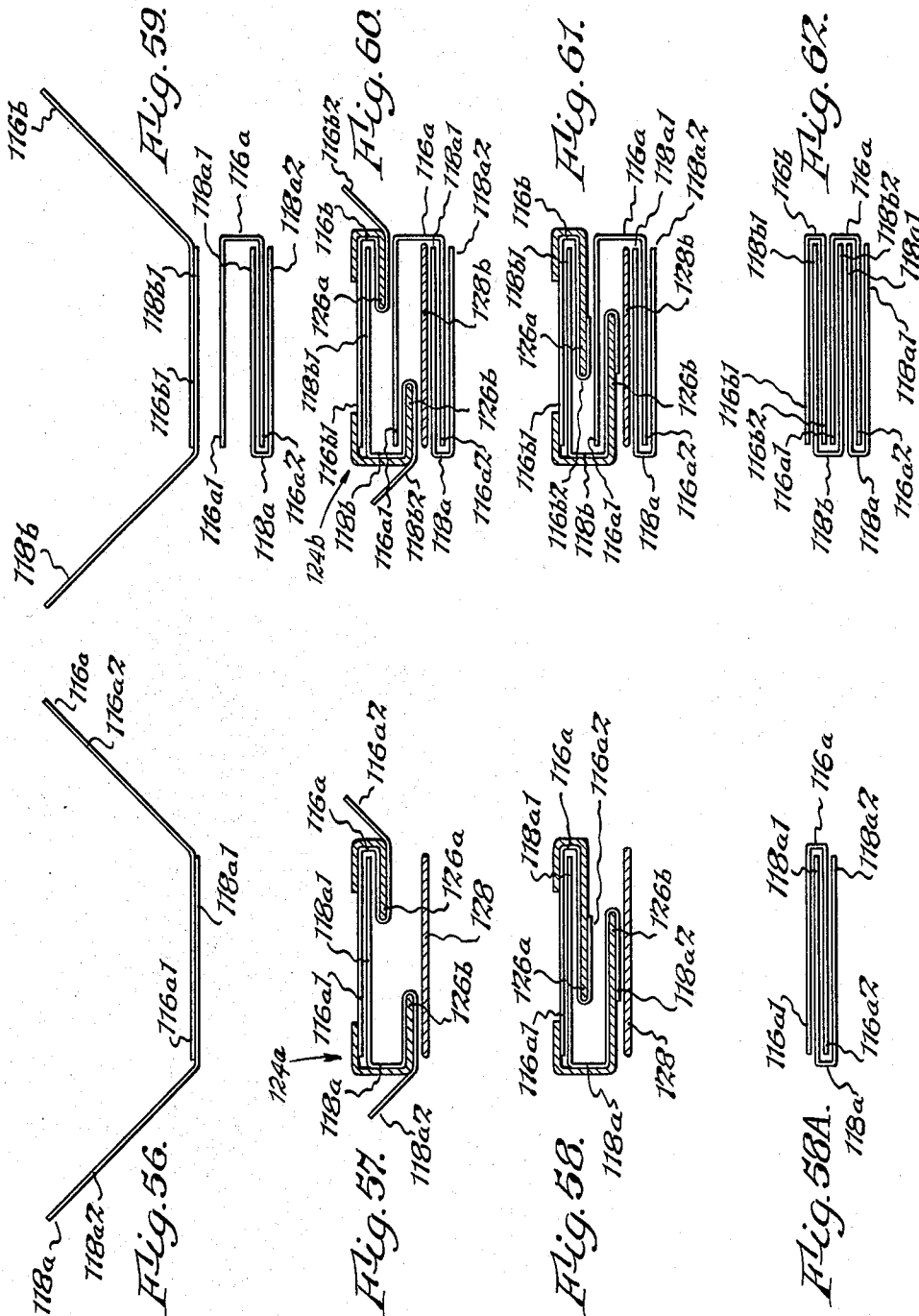
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WEB FOLDING MACHINE

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WEB FOLDING MACHINE

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Filed Mar. 7, 1963, Ser. No. 265,303
27 Claims. (Cl. 270-40)

This invention relates to method and apparatus for interfolding a succession of webs, and more particularly has to do with the production and packaging of paper facial tissues and the like with the individual sheets of tissue interfolded with each other in such a manner that when placed in a box the withdrawal of one tissue will expose the succeeding tissue for easy withdrawal, a feature sometimes designated as "pop-up tissue."

The consumer paper goods industry has long wanted a packaged facial tissue in the form of tissue sheets held in folded condition in a package with a leading edge of a sheet exposed for easy withdrawal and the withdrawal of which exposes a leading edge of the next sheet and in which at the same time, if desired, a partial stack of sheets may be withdrawn from the package still leaving an exposed portion of a next sheet for later withdrawal and without disrupting the remainder of the package.

No one has heretofore been able to interfold successive tissues on a commercially satisfactory basis so as to provide a "pop-up" feature which is solely dependent upon the interfolding of the tissues. Consequently make-do expedients have been adopted by manufacturers such as the provision of a restricted opening in the top of the tissue container which causes a distortion of the sheet of tissue as it is being withdrawn which brings out a leading portion of a succeeding tissue. Other manufacturers have given up on the "pop-up" feature and instead simply provide a box with a wide opening thus making it necessary for the user to reach in and grab a tissue sheet.

There seem to be two principal reasons for the difficulty, among others. The first is the failure to provide a simple and workable folding operation. Attempts have been made to interfold successive webs of tissue, for instance by introducing a third successive web into a folding operation being performed on prior first and second webs, making the operation unnecessarily complex and subject to breakdown. While the folding art has been highly developed, it has not, prior to this invention, provided a workable solution to the problems which arise in interfolding material having the peculiar characteristics of paper tissue in the long web lengths which are involved while building up the layers of tissue into a stack. The second reason for difficulty is the failure to provide a machine of workable size with an efficient way to load and keep the operation supplied with the many rolls of tissue which are required in a facial tissue packaging operation.

A commercial consumer size box of tissue may contain 360 separate sheets of tissue in short lengths cut from a long stack. In any facial tissue operation the stack is built up by bringing together 360 separate tissue webs from 360 separate supply rolls of tissue which are carried on extended rows of roll supports on a machine which is consequently very long and cumbersome, perhaps 200 to 400 feet long. And because in the ordinary machine the rolls become exhausted and have to be replaced in a random manner, machine operators must walk up and down the machine to look for exhausted rolls and to load fresh tissue supply rolls on an indiscriminate and somewhat unpredictable schedule. At the same time they must watch long runs of tissue which are

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easily subject to breakage. The rolls become exhausted while feeding into the middle of the stack and a break occurs. When that happens, the entire stack has to be scrapped causing large wastage of paper. Consequently prior machines are cumbersome and expensive to operate.

The present invention is useful wherever a stack or package of interfolded webs is required. It overcomes the above described and other disadvantages and achieves its primary object particularly in facial tissue manufacture in providing a machine and method for interfolding a succession of webs as more fully described herein and shown in the accompanying drawings in which:

FIG. 1 is a partial top plan of one version of the machine.

FIG. 2 is a partial side elevation of the machine partly in section and taken on line 2-2 of FIG. 1.

FIG. 3 is a partial plan similar to FIG. 1 showing tissue webs being interfolded.

FIGS. 4 and 5 are perspectives of adjacent folding devices and also showing in dot-dash lines the positions of the tissue webs being folded.

FIGS. 6 and 7 are perspectives of guard elements for the folding devices of FIGS. 4 and 5 respectively, these being shown in operative position in FIG. 1.

FIGS. 8-17 inclusive are vertical sections through the tissue webs and the folding devices taken on lines 8-8 to 17-17 respectively of FIGS. 3, 4 and 5 showing progressive interfolding of three successive tissue webs.

FIGS. 18 and 19 are side elevations which taken together show a second version of the machine.

FIG. 20 is a partial elevation of the machine of FIGS. 18 and 19 taken partly in section on line 20-20 of FIG. 23.

FIG. 21 is a partial elevation of the drive mechanism taken partly in section on line 21-21 of FIG. 23.

FIG. 22 is a partial plan showing a web roll and folding device support on a trolley taken partly in section on line 22-22 of FIG. 23.

FIG. 23 is a partial elevation showing the web roll and folding device support on the trolley taken partly in section on line 23-23 of FIG. 18.

FIGS. 24 and 25 are enlarged partial elevations similar to FIG. 20 showing various positions of the cam arms linkages and associated mechanism for spacing the web roll supports apart and bringing them closer together in the machine of FIGS. 18 and 19.

FIG. 26 is a perspective from below of two of the folding devices and their supports in the machine of FIGS. 18 and 19.

FIG. 27 is a perspective from below of the right-hand folding device of FIG. 26 with the guard element removed for clarity.

FIG. 28 is a perspective from below of two successive webs of tissue being interfolded by the folding devices of FIG. 26 but with folding devices and all other operative parts removed for clarity.

FIGS. 29-33 inclusive are successive vertical sections through the tissue webs, with all operative parts removed for clarity, taken along lines 29-29 to 33-33 inclusive in FIG. 28.

FIG. 34 is a partial side elevation of a third version of the machine.

FIG. 35 is a partial plan showing conveyor mechanism taken partly in section on line 35-35 of FIG. 34.

FIG. 36 is an end elevation taken partly in section on line 36-36 of FIG. 34.

FIG. 37 is a partial elevation showing drive mechanism taken partly in section on line 37-37 of FIG. 36.

FIGS. 38 and 39 taken together comprise a top plan of a fourth version of the machine in partially diagrammatic form.

FIGS. 40 and 41 taken together comprise a side elevation of the machine of FIGS. 38 and 39.

FIGS. 42-44 inclusive are partial enlarged elevations of the machine of FIGS. 38-41, with parts removed for clarity, showing the closure means including the linkages and cam for bringing the web roll supports closer together and wider apart during their movement by the conveyor mechanism.

FIG. 45 is an enlarged partial side elevation corresponding to FIGS. 40 and 41 showing a lower web roll on its support and a folding device interfolding two webs of tissue from the lower and upper webs rolls into a stack of interfolded tissue.

FIG. 46 is an enlarged partial end elevation taken partly in section on the line 46-46 of FIG. 45.

FIG. 47 is an enlarged partial end elevation partly in section taken on line 47-47 of FIG. 45 showing details of the conveyor means for the folding devices and web roll supports.

FIG. 48 is a partial plan partly in section taken on the line 48-48 of FIG. 45.

FIG. 49 is a partial elevation similar to FIG. 45 showing a different position of the folding device on a low stack of tissues.

FIG. 50 is a perspective from below of two folding devices and two groups of tissue webs being interfolded into a stack on the machine of FIGS. 38-41 but with the guard elements removed.

FIG. 51 is a fragmentary perspective from above partly in section showing two groups of tissues interfolded into a stack, as also shown in FIG. 50.

FIG. 52 is another perspective from below of a folding device of FIG. 50 but with its guard element removed.

FIG. 53 is another perspective from below of the folding device of FIG. 52 with the guard element.

FIG. 54 is a plan of the folding device of FIG. 52 partly in section on line 54-54 of FIG. 45.

FIG. 55 is a partial end elevation of the folding device of FIGS. 52-54 and its support, taken partly in section on line 55-55 of FIG. 54.

FIGS. 56-62 are sections showing the interfolding of the two groups of tissue webs taken on corresponding lines 56-56 to 62-62 of FIGS. 50 and 51.

Generally speaking, the process of making packages of facial tissue consists of drawing together and folding into a continuous stack many tissue webs from a long line of tissue supply rolls—one for each web in the stack. The stack is cut off into convenient lengths which are then packaged in wrappers or paperboard boxes which go to the consumer.

In a simplified version of the present invention the supply rolls are mounted in a fixed position so as to feed and build their individual webs onto a stack which is moved relative to the supply rolls. But where three or four hundred supply rolls each three or four feet in diameter may be required, this results in an inconveniently long apparatus. Accordingly, this invention also includes more sophisticated and efficiently operating versions of the apparatus in which the supply rolls are mounted to travel in a closed path countercurrent to the direction of the movement of the stack of tissue webs so that the relative movement of the webs and the supply rolls is the resultant of the combined movement. This provides an apparatus which need be only half as long or less and in which the exhausted supply rolls can be replenished at one reloading station on the machine, thus eliminating the necessity for the operators to reload exhausted tissue rolls at random points over the entire length of the machine.

Four versions of the various possible combinations of apparatus and method covered by the invention will be described, with the understanding that features of these may be combined into various other versions.

Referring to FIGS. 1-17 inclusive showing the first version of the apparatus and its mode of operation, FIGS.

1 and 2 show a framework 10 on which there are mounted in fixed position a series of web roll supports 12 for supporting web rolls 14 from which webs 16 of material, for instance facial tissue, are drawn up from below and interfolded into a stack 18 which is moved away to the left as seen in FIG. 2 by conventional belts 20 and rolls 22, to be cut and packaged in useful lengths in the usual manner. While only three web roll supports are shown, the machine may include from perhaps twenty more or less to several hundred supply roll supports and associated mechanisms, depending upon the number of tissue sheets required in the consumer package.

Each web 16 is drawn through and moved relative to a folding device 24, by which it is folded with a successive web and into superposed relation in the stack 18. As seen in FIG. 1, the web roll supports 12 and folding devices are alternately somewhat staggered or offset from each other edgewise of the webs to facilitate interfolding of the webs. In FIG. 1 it will be seen that the folding devices 24a, 24b and 24c have biased elements 26a 26b and 26c which are opposed in direction left and right with respect to each other. Each of the folding devices 24 has a guard element 28 arranged in spaced relation to its biased element 26 and these also are arranged in correspondingly opposed or left and right arrangement, as shown by the guard elements 28b-28c. The guard element 28 is omitted from the right-hand folding device 24a in FIGS. 1-3 because there is no prior web to be interfolded and so it is not required. The folding devices 24a and 24b with their opposed biased elements 26a and 26b are more clearly shown in FIGS. 4 and 5 with corresponding guard elements 28a and 28b separately shown for clarity in FIGS. 6 and 7.

Referring to FIGS. 2 and 5 the web 16a is drawn up from its supply roll 14a over a guide 15a and one edge portion 16a1 rides up an inclined part 25a of the folding device 24a and onto the horizontal part 27a while the other edge portion 16a2 of the web at first becomes inclined downwardly as also seen in FIG. 8 and then rides up over the biased element 26a as also seen in FIGS. 9 and 10, thereby folding the edge portion 16a2 over the edge portion 16a1 as also seen in FIGS. 10A and 11, thereby folding the web 16a which may be descriptively called the first web.

Likewise, as best seen in FIGS. 11-13a, the successive web 16b is drawn from its supply roll 14b over a guide 15b. One edge portion 16b1 is placed by the horizontal part 27b adjacent the first web 16a and outside both its folded edge portions 16a1 and 16a2. Because the biased element 26b is opposed to the biased element 26a, the second web 16b is folded opposed to the first web 16a with its opposite edge portion 16b2 over the edge portion 16b1 and placed by the biased element 26b between the folded edge portions 16a1 and 16a2 of the first web 16a.

The guard element 28b is arranged in spaced relation to the biased element 26b to separate the folded edge portions of the first web 16a by holding the edge portion 16a2 clear of the biased element 26b so that it may enter between the folded edge portions 16a1 and 16a2.

As seen in FIGS. 10A and 13A, the folded edge portions 16a1 and 16a2 of the first web 16a are flattened before the opposite edge portion 16b2 of the second web 16b is placed between them so that every web is folded with its edge portions flattened before the successive web is placed adjacent to it.

FIGS. 14 and 17 in connection with FIG. 3 show a succeeding web 16c from a web supply roll 14c passing through the folding device 24c over the biased element 26c and under the guard element 28c as it is interfolded into stacked relation with the other webs in the stack 18. The folding operation on the web 16c is essentially the same as that performed on the web 16a and the folding device 24c is identical to the folding device 24a.

In a second version illustrated in FIGS. 18-33 inclusive the folding devices and the web rolls and their sup-

ports are progressively moved in a closed path around horizontal axes and countercurrent to the movement of the web stack while the webs are fed downwardly from the rolls and interfolded into the stack.

A framework 30 has a track 32 in a closed path riding in which are a series of trolleys or carriers 33 best seen in FIGS. 20 to 25. Rigidly mounted on the trolleys 33 are folding devices 34 carried on arms 35. Mounted also on the trolleys 33 as best seen in FIGS. 22 and 23 are web roll supports 39. As best seen in FIG. 23 the alternate folding devices 34 and web roll supports 39 are slightly staggered or offset with respect to each other in a horizontal direction edgewise of the webs to facilitate the interfolding of the webs 46 from the web rolls 44 into the stack 48.

The folding devices 34 and their support arms 35 assume the progressive positions shown in FIGS. 18 and 19 under the control of the trolleys 33 in the track 32.

Pivotaly mounted on the trolleys 33 are cam arms 50, the ends of which ride in a track 52 forming a cam in the frame 30 which controls their progressive relative rotative position. The cam arms are connected with each other by linkages 54 in the form of flexible chains which with the cam arms 50 and cam 52, as best seen in FIGS. 20, 24 and 25, act as closure means which operate progressively by rotation of the cam arms 50 to bring the web roll supports 39 on the trolleys 33 closer together or wider apart since the trolleys 33 are movable relative to each other along the closed path formed by the track 32.

The trolleys 33 and associated parts including the folding devices 34, web roll supports 39 and web rolls 44 are driven around the track 32 in a counterclockwise direction as seen in FIGS. 18-21 by lugs 56 on the trolleys 33 which are engaged by corresponding lugs 58 on a chain 60 driven by a sprocket 62 and a drive motor 64, as best seen in FIG. 21. Since all of the trolleys 33 are interconnected by the linkages 54, driving any one or more of them along the track 32 moves all of them as a train in the closed path.

Referring to FIGS. 18 and 19 the interfolded stack 48 of webs is moved to the left toward cut-off and packaging mechanisms by feed means such as a conveyor belt 66 which forms a support for the stack and another conveyor belt 68 pressing downwardly on the stack to grip it.

Accordingly, the web rolls 44 and folding devices 34 on the lower part of the closed path move to the right while the stack of tissues 48 moves to the left so that the interfolding rate is the resultant motion between them. The empty web roll supports 39 move to the left along the upper part of the closed path, on any part of which, such as at the left-hand end of the loop path on the frame 30, FIG. 18, may be established a load position at which a new web roll 44 is loaded on each web roll support 39 as it moves to a position to feed a web to the stack 48. The web rolls 44 become progressively exhausted as they move toward the right-hand end of the machine seen in FIG. 19. The sizes of the web rolls may be arranged so that each web roll becomes exhausted as its support 39 reaches a predetermined point as it moves to the right and upwardly away from the stack. The point of exhaustion of each web roll, and consequently the number of web rolls which pass the stack before it leaves the belt, can also be controlled by adjusting the speed of movement of the drive roll supports along the closed path. This will determine the number of webs which can be laid in the stack.

As the diameters of the web rolls diminish in their movement to the right, less clearance is required between them so that their supports 39 and the folding devices 34 may be brought progressively closer together by the closure means 54 as the web rolls are exhausted. The purpose of this arrangement is to provide a much shorter machine than would otherwise be required.

The details of the folding devices 34 and their mode of operation in the machine of FIGS. 18 and 19 are shown in FIGS. 26-33. The respective web supply rolls 44a and 44b unwind counterclockwise and webs 16a and 16b are fed downwardly from them and over guides 45, specifically 45a and 45b. In FIG. 26 a pair of adjacent folding devices descriptively called first and second folding means 34a and 34b have opposed biased elements 36a and 36b and guard elements 38a and 38b. In FIG. 27 the guard element 38a is removed for clarity. In FIG. 28 two webs 46a and 46b are being interfolded as by the folding devices 34a and 34b in FIG. 26 but in FIG. 28 the operative elements of FIGS. 26 and 27 are removed for clarity.

The edge portion 46a1 of the first web 46a rides down over the inclined part 55a and under the horizontal part 37a and the other edge portion 46a2 is at first inclined angularly and then rides over the biased element 36a which folds the edge portion 46a2 over the edge portion 46a1 as seen in FIGS. 28 to 30a.

Similarly the edge portion 46b1 of the second web 46b rides down over the inclined part 55b and under the horizontal part 37b and is thereby placed adjacent the first web 46a and outside both its folded edge portions 46a1 and 46a2 while the edge portion 46b2 first becomes inclined angularly and then rides over the biased element 36b which being opposed to the biased element 36a folds the web 46b in the opposite direction and with the edge portion 46b2 folded over the edge portion 46b1. As seen in FIGS. 28 and 31-33 the edge portion 46b2 of the second web 46b is placed between the folded edge portions 46a1 and 46a2 of the first web 46a. Successive webs 46 are similarly interfolded into the stack 48.

The guard element 38b is arranged in spaced relation to the biased element 36b to separate the folded edge portions of the first web 46a by holding the edge portion 46a2 clear of the biased element 36b so that the latter may enter between the folded edge portions 46a1 and 46a2 to place the edge portion 46b2 between them.

In this version also each web is folded with its edge portions flattened before the succeeding web is placed adjacent to it and its edge portion placed between them.

A third version shown in FIGS. 34 to 37 is similar to the second version in that the folding devices 74 which may be identical to the folding devices 34 are also mounted to travel in a closed path around horizontal axes to interfold the stack 68 of tissues while the latter is moved to the left by the upper run of a conveyor belt 86 and another belt 88 pressing downwardly on it. The folding devices are carried on arms 75 rigidly mounted on trolleys 73 which are directly pivotally connected together as best seen in FIG. 35 to ride in a track 72. Since the arms 75 are rigidly mounted with respect to the trolleys 73 they progressively assume the positions illustrated in FIG. 34. Alternate arms 75a and 75b have web roll mountings 79a and 79b alternately mounted respectively at a spaced distance from the track 72 and at or near the track so that the web rolls 84 specifically designated 84a and 84b on their respective web roll supports 79a and 79b are arranged in a vertically staggered relation along the bottom run of the closed path with the result that the web rolls 84 on their supports may be closely crowded together as they travel along the path while feeding the webs to the stack 68.

With this arrangement a comparatively shorter machine may be provided and without the linkages and associated mechanism provided in the above described second version for moving the roll supports together and spreading them apart during their travel along the path. Nevertheless such a linkage arrangement may also be provided in this version.

The train of interconnected trolleys 73 is driven around the track 72 by the drive mechanism best seen in FIG. 37, in which a drive motor 76 is connected by a gear

train 77 to a shaft 80 and sprocket 81 which drives the trolleys 73 as they pass around the curved portion 82 of the track 72.

A fourth version generally illustrated in FIGS. 38 to 41 has successive folding devices and web roll supports interconnected to travel in a closed path arranged predominantly around vertical axes generally in a horizontal plane.

A framework 90 has top and bottom trackways 91 and 92 in a closed path best seen in detail in FIG. 47 which carry a succession of trolleys 93.

As best seen in FIGS. 42-44 and 47, the trolleys 93 are connected together into a continuous train by cables 95 attached to the trolleys at terminals 97. The train of trolleys is moved by variable speed drive mechanism including a motor 140, a gear box 142 and a sprocket chain 144. Lugs 146 on the sprocket chain 144 engage bosses 148 on two or three of the trolleys 93 which are passing the drive mechanism at any point of time.

The cables 95 connecting the trolleys extend horizontally between pulleys 99 fixed on the trolleys 93 and then upwardly and over pulleys 101 which are mounted on cam arms 103 arranged to be swung generally up and down on pivots 105 on the trolleys 93. The outer ends of the cam arms 103 are guided upwardly and downwardly by a cam track 107 on the framework 90 around the closed path and best seen in FIGS. 42-44 and 47.

The cables 95, cam arms 103, cam 107 and associated mechanisms accordingly act as closure means which operate progressively to bring the trolleys 93 closer together or wider apart in accordance with the respective upward and downward rotative positions of the cam arms 103 as determined by the varying relative height of the cam track 107 as the trolleys 93 move in the closed path around the tracks 91 and 92.

Each trolley 93 has mounted on it a column 110 which as perhaps best seen in FIG. 47 carries upper and lower web roll supports 112 and 113 on which may be mounted upper and lower web rolls 114a and 114b and at its lower end a folding device 124. A pair of webs 116 and 118 from the lower and upper web rolls 114a and 114b are fed downwardly over a guide 121 to the folding device 124 and into a stack 120 which is moved away to the left as seen in FIGS. 38, 39 and 45 by a conveyor belt 122 which extends along the full length of the machine.

By comparing FIGS. 45 and 49 it is seen that each folding device 124 is supported to move up as the web stack height increases. It is mounted on a parallelogram mechanism indicated at 135 comprising the members 136, 138 and 240 pivoted together and supported on pivots 242 and 244 on a vertical arm 246 which is supported on a cross arm 248 on the column 110. Thus the folding device has a support providing movement to and away from the web conveyor and which constrains it so as to maintain a constant orientation with respect to the conveyor.

As best seen in FIGS. 46 and 48 each folding device has a sprocket 150 on a shaft 151 which is actuated by a drive chain 152 extending the entire length of the front of the machine. The sprocket 150 turns another sprocket 154 on the shaft 151. This drives a chain 156 and a drive roll 158 on a shaft 160 on the parallelogram mechanism 135 to ride with the folding devices 124 up and down on the top of the stack 120. The weight of this unit is partly counterbalanced by a spring 127. Thus, the folding devices 124 may rise upwardly while remaining level as the height of the stack 120 is increased by additional interfolded webs and the drive roll 158 pressing downwardly on the web stack due to the weight of the unit cooperates with the conveyor belt 122 to move the web stack 120 to the left.

The drive chain 152 may be inclined at the ends of the machine so as to disengage and re-engage the sprockets 150 as the trolleys 93 leave and enter their operative positions.

The drive chain 152 and the conveyor belt 122 are driven at the same or a proportionate speed by conventional variable speed drive means which are not shown. Since the drive roll 158 is driven by the relative movement of the trolley 93 to the right end of the belt 122 and chain 152 to the left, its surface speed may always be the same as the speed of the belt 122 relative to the movement of the trolley even though such relative speed may be varied. Thus the drive roll 158 helps to draw the webs from the rolls and onto the conveyor belt.

As seen in FIGS. 38-41, as the web rolls 114a and 114b are exhausted during their movement to the right the trolleys 93 are brought progressively closer together by the action of the cam track 107 which inclines upwardly to raise the cam arms 103 and that during the return of the empty roll supports 112 and 113 to the left along the back of the machine they are spread further apart by downward inclination of the cam track 107 to provide a delay time for reloading the web roll supports with fresh web rolls at the reloading station at the left-hand end of the machine as seen in FIG. 38.

The construction of a folding device 124 is best seen in FIGS. 52-55 and its mode of operation with an adjacent folding device for interfolding the tissue webs in FIGS. 50-51 and 56-62.

Each folding device 124 has a pair of upper and lower opposed biased elements 126a and 126b for interfolding a group comprising the two webs 116 and 118 with each other and into the stack 120 and a guard element 128 arranged in spaced relation to the biased element 126b to hold edge portions of prior folded webs clear so that the biased element 126b may enter between them.

As best seen in FIG. 50 the webs 116a and 118a are drawn downwardly to the folding device 124a over the guide 121a somewhat offset from each other laterally or edgewise. The overlapping edge portions 116a1 and 118a1 pass over the guide 122a. The edge portions 116a2 and 118a2 are at first inclined as seen in FIGS. 50 and 56 and then they ride over the biased elements 126a and 136b, thus interfolding the edge portions 116a1 and 116a2 with the edge portions 118a1 and 118a2 as best seen in FIGS. 57, 58 and 58a. In FIG. 50 the guard elements 128 have been removed for clarity.

Likewise the adjacent webs 116b and 118b are fed downwardly over the guides 121b and 122b and are interfolded with each other on the folding device 124b and with the adjacent web 116a as particularly seen in FIGS. 50 and 51 and 59-62. As seen in FIGS. 60 and 61 the guard element 128b separates the folded edge portions 116a1 and 116a2 and holds the edge portions 116a and other web portions clear of the biased element 126b so that it may enter between them to interfold the edge portion 118b2 of the web 118b. Thus, the adjacent folding devices 124a and 124b are arranged to interfold successive groups of webs into the stack 120 and successive folding devices 124 operate in the same manner to interfold successive webs with each other and into the stack 120.

Since the rolls may be replenished at a fixed loading point, the supply may be economically handled and controlled. And by adjusting the feed rate of the rolls, any number of sheets may be placed in the stack without the need for extending the machine to an unwieldy size.

What is claimed is:

1. In a machine for interfolding a succession of webs in stacked relation, means for moving a stack of webs, a plurality of devices for feeding successive webs into the stack, conveyor means for moving the said devices in a closed loop path at least a part of which is parallel and countercurrent to the movement of the stack while the devices are feeding successive webs into the stack, and web roll supports carried by the conveyor means for supplying at least one web to each said folding device.

2. In the machine as set forth in claim 1, said web roll supports being arranged in a staggered relation along

said path whereby web rolls on said supports may be closely crowded together along said path.

3. In the machine as set forth in claim 1, said closed loop path being arranged predominately around vertical axes.

4. In the machine as set forth in claim 1, said web roll supports being movable relative to each other along said closed path and closure means operable progressively to bring said supports closer together as web rolls on the supports are exhausted while supplying webs to the folding devices.

5. In the machine as set forth in claim 4, said closure means comprising linkages between said supports and a cam which shortens said linkages.

6. In the machine as set forth in claim 4, said closure means also being operable progressively to bring said supports wider apart during their return along said closed loop path to a reloading position.

7. In a machine for interfolding a succession of webs in stacked relation, a conveyor belt for moving a stack of interfolded webs, a plurality of folding devices for interfolding successive groups each of at least two webs into the stack whereby each web is doubled over longitudinally with the folded edges of each web lying between the folded edges of the adjacent webs, conveyor means for moving the folding devices in a closed loop path at least a part of which is parallel and countercurrent to the movement of the stack while the devices are interfolding successive groups of webs into the stacks, and web roll supports carried by the conveyor means for supplying at least two webs to each said folding device.

8. In a machine for interfolding a succession of webs having a conveyor belt for moving a stack of interfolded webs, folding devices and means for moving the folding devices countercurrent to the movement of the belt and in combination, drive means moving in timed relation with the conveyor belt, means levelly supporting the folding devices at variable heights, drive rolls on the folding devices arranged to rest on a said stack of interfolded webs, and drive transmission means connecting the drive rolls with the drive means, said drive rolls thereby cooperating with the conveyor belt to move the stack of webs and also being responsive to the height of the stack to adjust the operative height of the folding devices.

9. In the machine as set forth in claim 8, said drive means being a drive chain mounted parallel to and being moved with the conveyor belt.

10. In the machine as set forth in claim 9, said support means for the folding devices comprising parallelogram mechanisms having one end vertically immovable and the other end vertically movable and said drive transmission means comprising sprockets on the vertically immovable ends engaged to the drive chain and belt chains connecting the sprockets to the drive rolls.

11. Method of interfolding a succession of webs in stacked relation which comprises the steps of feeding successive webs from roll supports into a stack, while interfolding the adjacent webs by doubling over longitudinally each web and placing its edges between the folded edges of the adjacent webs, moving the stack in one direction and moving the roll supports in the opposite direction in a closed loop path.

12. In the method as set forth in claim 11, varying the speed of movement of the roll supports in accordance with the number of webs to be interfolded into the stack.

13. In a machine for interfolding a succession of webs, at least one folding device having upper and lower opposed biased elements one superposed above the other at a single location in the path of a group of at least two of said webs for interfolding the webs of said group, said webs in the group being partially superimposed to provide extending edges, one said biased element operating to double an edge of one web over with respect to its other edge while the other said biased element operates simultaneously to double an edge of the second web over with respect

to its other edge and to place it between the edges of the first web.

14. In the machine as set forth in claim 13, one of said biased elements also operating to place an edge of one of said webs between the edges of a web which edges have been previously doubled over by another said device in the machine.

15. In the machine as set forth in claim 1, means to vary the speed of the conveyor means relative to the movement of the feeding devices.

16. In a machine for interfolding a succession of webs in stacked relation, a conveyor for moving a stack of interfolded webs along a linear path, a plurality of folding devices operable to interfold the webs into the stack by turning over their edge portions and placing them with edge portions of webs on the stack so that the edge portion of one web lies between the edge portions of another web, conveyor means for moving the folding devices in a closed loop path and successively in a direction parallel to said linear path and countercurrent to the movement of the stack along said linear path whereby the webs from the folding devices are fed longitudinally onto said stack as said stack and said folding devices are moved in opposite directions.

17. Method of feeding a succession of webs into a stacked relation which comprises the steps of feeding successive webs from a succession of web roll supports into a stack of said webs, moving the stack, and moving the roll supports successively in the direction opposite to the movement of the stack and in a closed loop path a part of which is substantially parallel to said linear path.

18. In the machine as set forth in claim 1, said devices being supported for movement up and away from the web stack moving means as the height of the web stack increases by additional webs being fed into it.

19. In a machine for interfolding a succession of webs, a first folding device having guide elements operable to receive a first group of at least two said webs, said first folding device being placed at a single location in the path of said webs in said first group, said webs in said first group being partially superimposed to provide extending edges, and simultaneously to fold an edge portion of each of the webs of said first group over an edge portion of another of the webs of said first group, and a second folding device having guide elements operable to receive a second group of at least two said webs, said second folding device being placed at another single location in spaced relation with respect to said first folding device and in the path of said webs in said second group, said webs in said second group being partially superimposed to provide extending edges, and simultaneously to fold an edge portion of each of the webs of said second group over an edge portion of another of the webs of said second group, and conveyor means arranged with respect to said folding devices and operable to receive and remove the interfolded webs of the first and second groups of webs in superimposed relation with respect to each other so as to form a stack of said webs.

20. In the machine as set forth in claim 19, folding means operable to place an edge portion of one of the webs of one of said groups under an edge portion of one of the webs of the other of said groups while the conveyor means is receiving and removing the interfolded webs of the first and second groups of webs in superimposed relation.

21. In the machine as set forth in claim 20, said folding means comprising one of the said guide elements of the said second folding device.

22. Method of interfolding a succession of webs in stacked relation which comprises the steps of feeding a first group of at least two said webs in partially superimposed relation to provide extending webs edges, then and at a first single location in the path of said webs in said first group simultaneously folding an edge portion of each

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of the webs of said first group over an edge portion of another of the webs of said first group, feeding a second group of at least two said webs in partially superimposed relation to provide extending web edges and at another single location in spaced relation with respect to said first single location and in the path of said webs in said second group simultaneously folding an edge portion of each of the webs of said second group over an edge portion of another of the webs of said second group, and then removing all of said above mentioned webs in a superimposed relation with respect to each other so as to form a stack of all said webs.

23. In the method as set forth in claim 22, placing an edge portion of one of the webs of one of said groups under an edge portion of one of the webs of the other of said groups.

24. In a machine for interfolding a succession of webs, at least one folding device having guide elements at a single location in the path of a group of at least two of said webs and operable to receive the webs of said group, said webs in said group being partially superimposed to provide extending edges, and simultaneously to at least commence folding a first edge portion of one web of said group over a second edge portion of another web of said group while at least commencing to fold a first edge portion of said another web over one of the edge portions of said one web and while at least commencing to place an edge portion of either of said webs in a position between edge portions of a web which is other than any of the webs of said group, and conveyor means arranged with respect to said folding device and said web which is other than any of the webs of said group and operable to receive and remove all of said above mentioned webs in superimposed relation with respect to each other so as to form a stack of all of said webs.

25. Method of interfolding a succession of webs in stacked relation which comprises the steps of feeding a group of at least two webs in partially superposed re-

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lation to provide extending web edges, then and at a single location in the path of said webs in said group simultaneously at least commencing to fold a first edge portion of one web of said group over a second edge portion of another web of said group while at least commencing to fold a first edge portion of said another web over one of the edge portions of said one web and while at least commencing to place an edge portion of either of said webs in a position between edge portions of a web which is other than any of the webs of said group, and then removing all of said above mentioned webs in superimposed relation with respect to each other so as to form a stack of all of said webs.

26. In a machine for interfolding a succession of webs, web conveyor means to move a stack of webs along a substantially horizontal path, a plurality of web folding devices spaced along the horizontal path above the web conveyor means, means to feed a web through each of the folding devices and successively onto the stack of webs, and means for supporting said folding devices for movement to and away from said web conveyor means including means constraining said devices to maintain a constant orientation with respect to said conveyor means.

27. In the machine as set forth in claim 26, said support means comprising parallelogram mechanisms.

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