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Orlovsky

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[54] SHEET FOLDING APPARATUS AND METHOD

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[52] **U.S. Cl.** .....**270/79**, 270/39, 270/61 F

[51] **Int. Cl.** **B65h 45/20**

[58] **Field of Search**.....270/79–83, 61, 270/39–40

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[57] **ABSTRACT**

In a semi-automatic sequence, paper sheets from a horizontal supply on top of the apparatus are manually advanced to a power-operated feed mechanism where each sheet is fed downwardly between a pair of vertical guides. While between these guides, the leading edge of each sheet engages a sensing switch to activate time delay means. The sheet continues to be fed between tucker or folder elements until a proper length of paper corresponding to the pre-established fold length has been fed past the tuckers. The time delay period is now terminated. Feeding of the sheet is interrupted and the vertical sheet is held by light tension at the start of the folding cycle. The automatic folding sequence continues until the trailing edge of the paper disengages the sensing switch, whereupon the tuckers cease to operate and resume a normal neutral position and the feed mechanism again becomes active for feeding the next sheet. The folded sheet drops onto a storage tray at the bottom of the apparatus for manual removal periodically.

12 Claims, 10 Drawing Figures

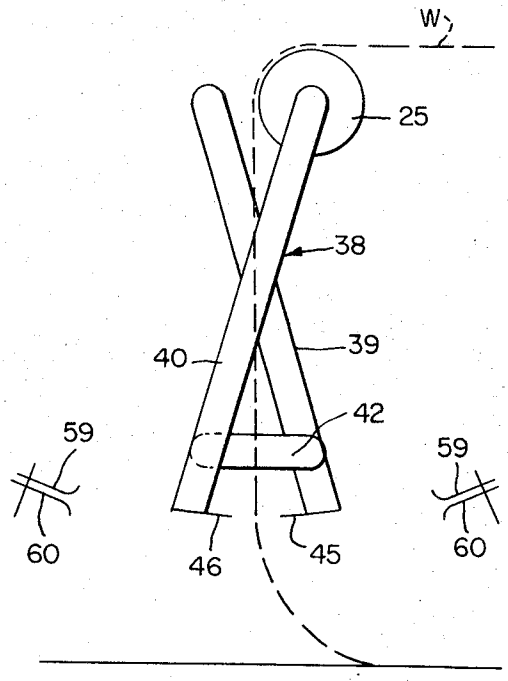


FIG. 1.

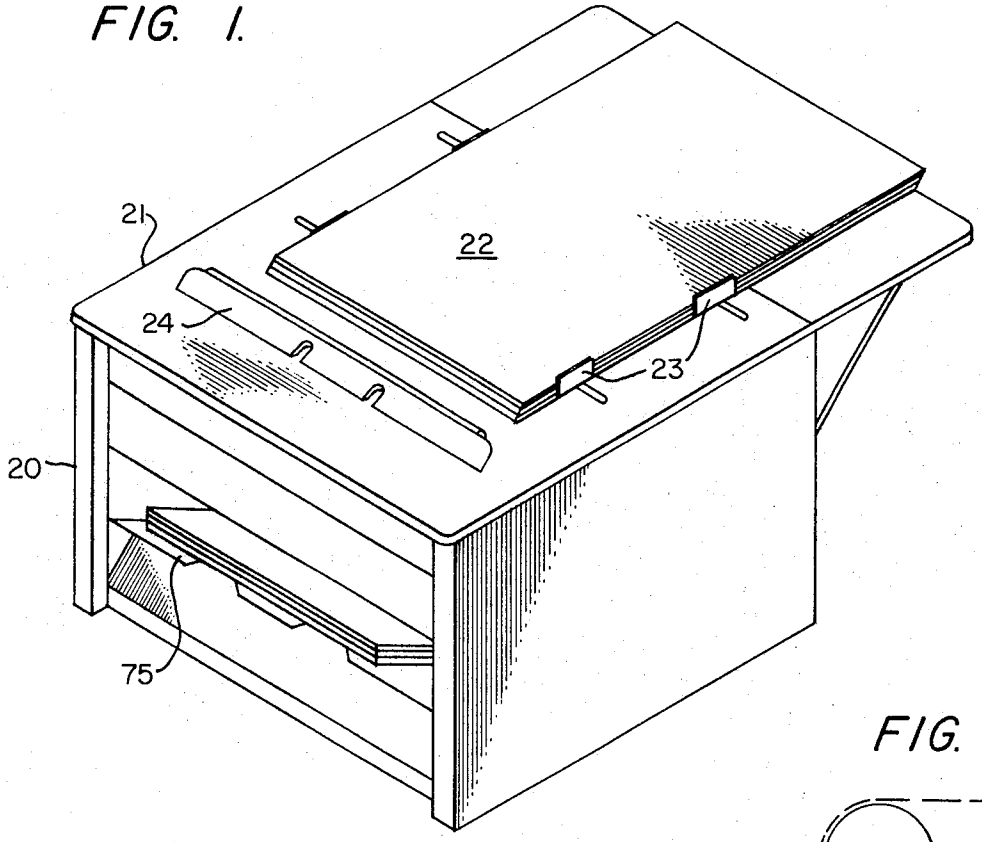


FIG. 5a.

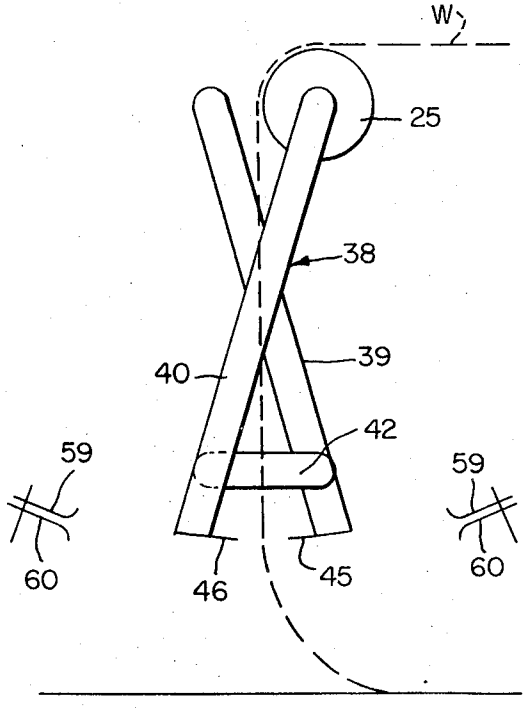
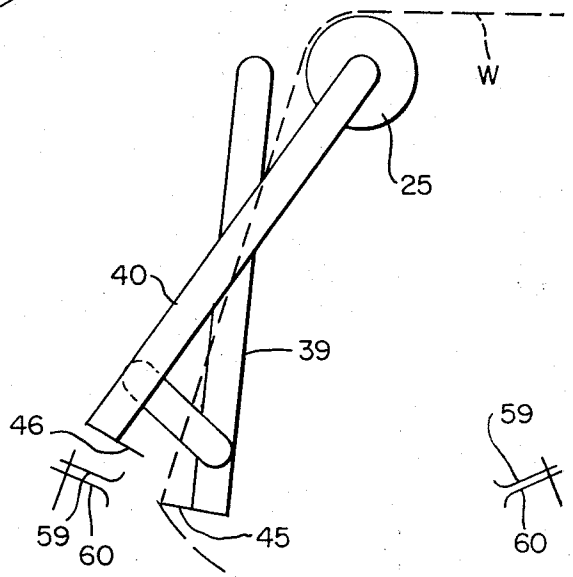


FIG. 5b.



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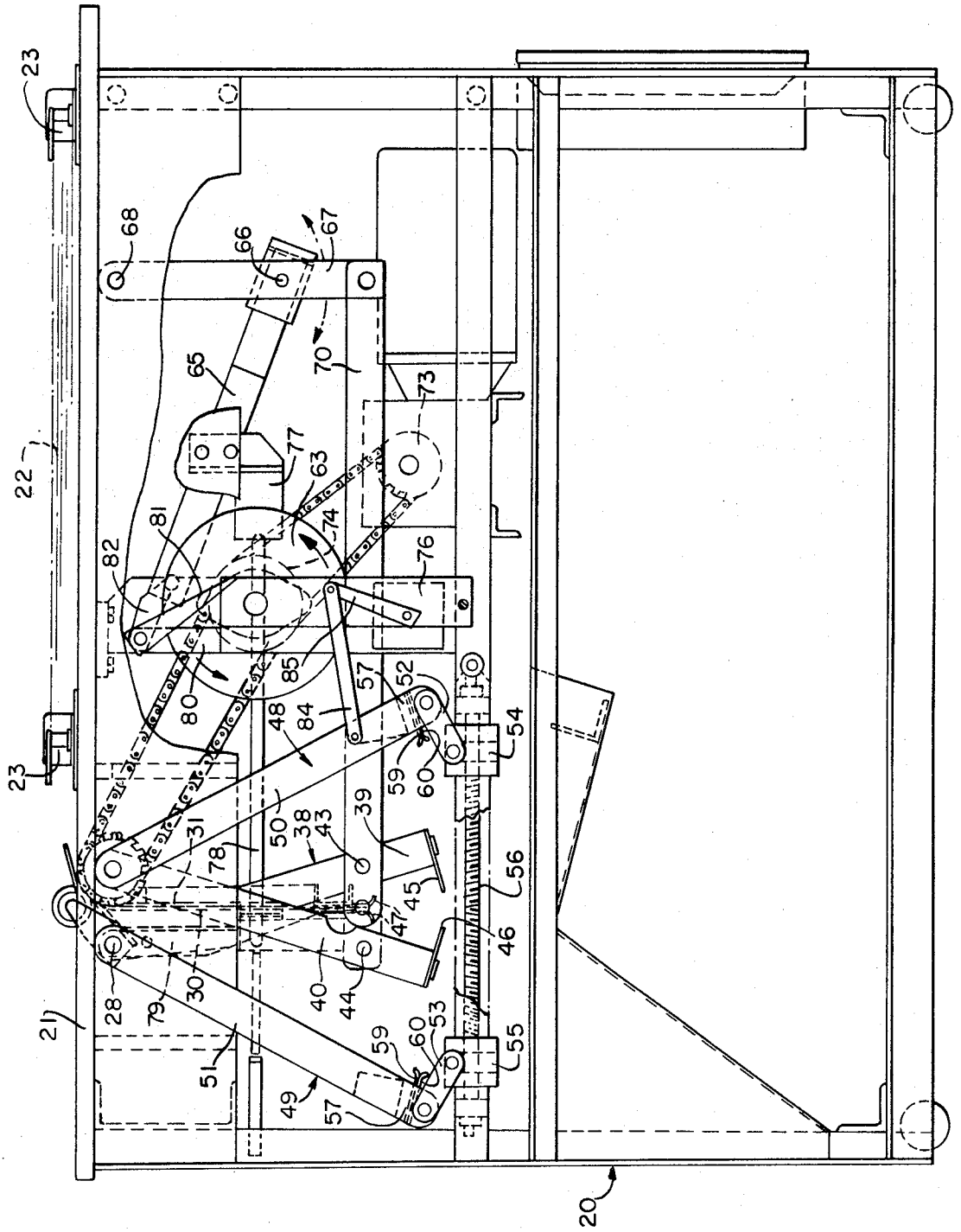


FIG. 2.

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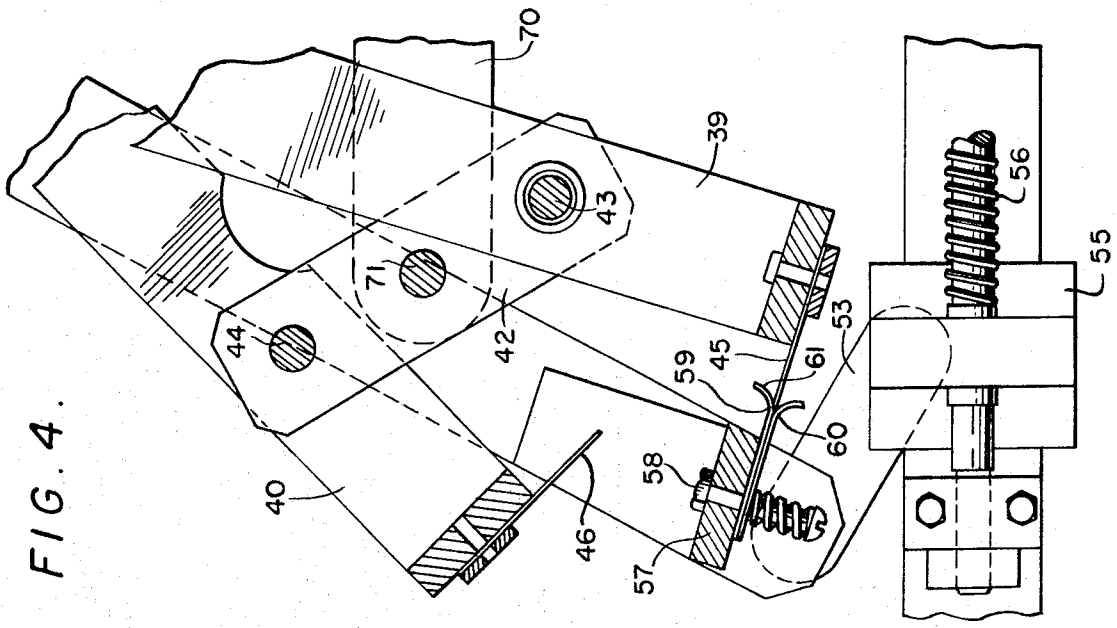


FIG. 4.

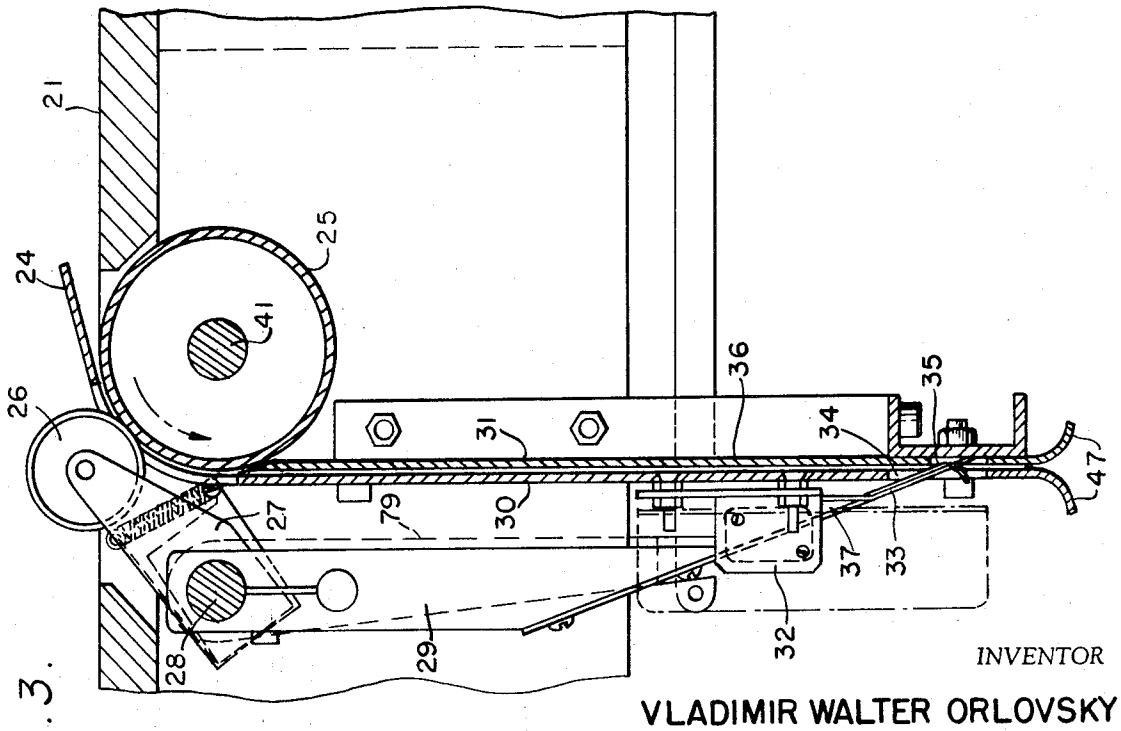


FIG. 3.

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FIG. 5c.

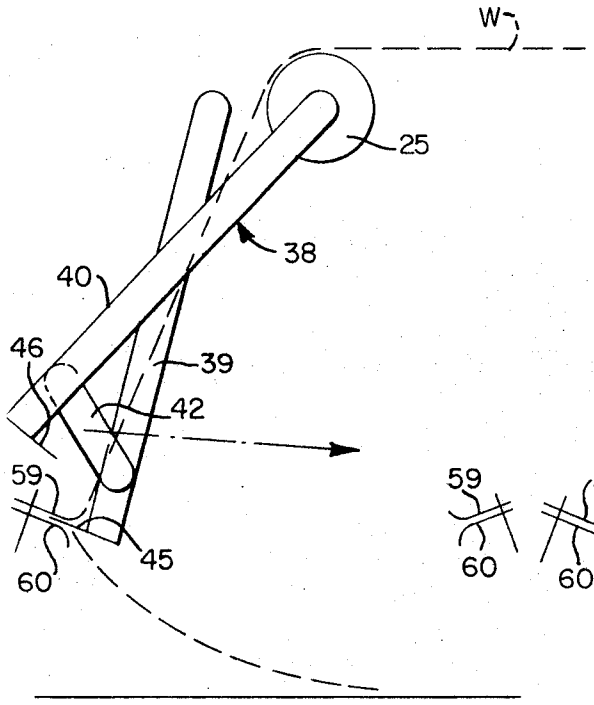


FIG. 5d.

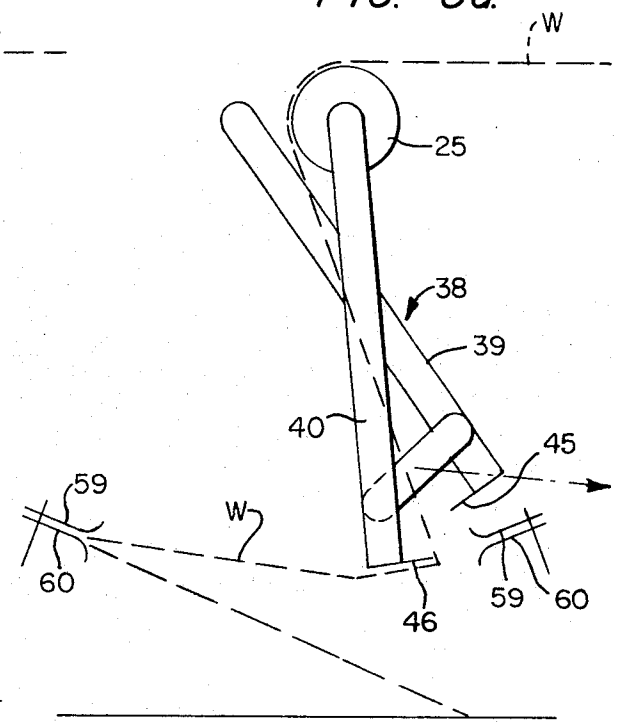


FIG. 5e.

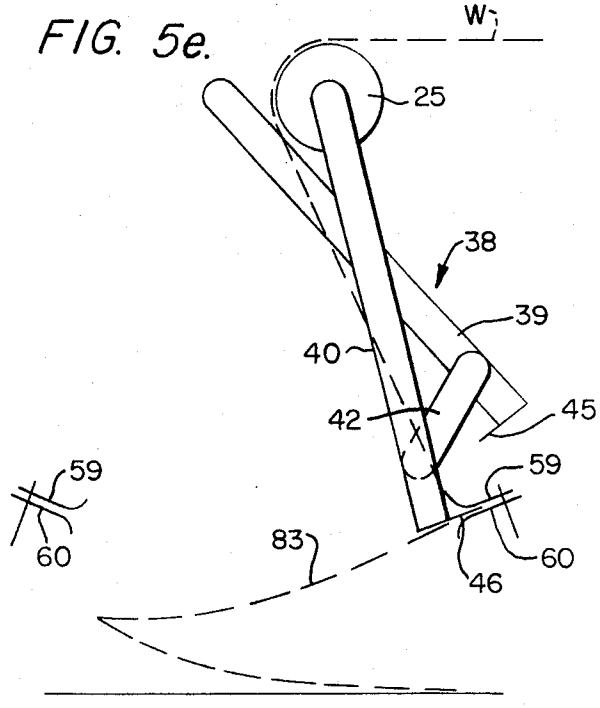
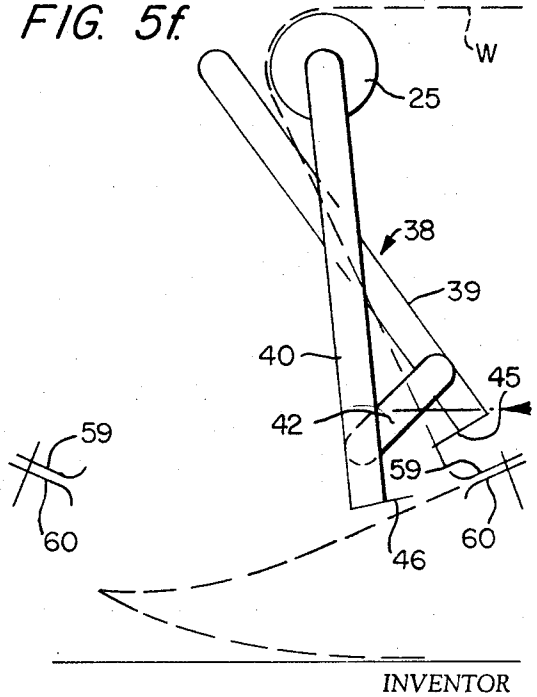


FIG. 5f.



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SHEET FOLDING APPARATUS AND METHOD

BACKGROUND OF THE INVENTION

Machines for continuously folding paper webs and the like are known in the prior art and two such examples are contained in the expired United States patents to Whitelaw, 622,579, and Wollheim, 980,385. In general, the prior art devices are complex and costly and have limited capability. For example, the width of the paper web which can be manipulated is strictly limited and the length of the folding area cannot readily be adjusted. These and other like deficiencies are overcome in the present method and apparatus by a much more simplified and economical structure which embodies a greatly improved mode of operation. Sheets or webs of unlimited width may be folded, and the length of the fold may be regulated through a wide range.

More particularly, the method of folding in the invention is greatly simplified and eliminates many parts which normally require sensitive adjustment and improved uniform results are obtained. In the above-mentioned Whitelaw patent, for example, the folding blades coact with gripper devices which require opening and closing as well as mechanism for dislodging the paper. In the present method and apparatus, by a smooth sequence of steps, the suspended paper web is engaged by one tucker blade and pushed into a first pair of spring-loaded grippers, followed by the retraction of the one tucker blade from the first grippers. A second tucker blade then engages the web at another point and delivers the same to a second pair of spring-loaded grippers and in so doing the paper web is tensioned and automatically removed from the first gripper means and the previously folded portion drops to the delivery tray or platform. The web is now held in the second gripper device where a second fold is produced and the tucker blades begin to swing in the opposite direction to repeat the cycle until the folding of the web is completed, depending upon the length of the web. No separate mechanisms are required to release the folded web from either gripper and the tucker means serve the dual function of producing the required folds in the web while drawing the paper web downwardly and automatically disengaging it alternately from the two grippers at proper times during the folding cycle. Simplified means are provided to adjust the spacing between the two gripper devices on arcs having the same centers as the tuckers. The tuckers derive their movement from a single crank mechanism whose throw may be varied. The mechanism is therefore very versatile.

Other features and advantages will be apparent during the course of the following description.

BRIEF DESCRIPTION OF DRAWING FIGURES

FIG. 1 is a perspective view of a sheet folding apparatus embodying the invention.

FIG. 2 is a side elevational view of the apparatus.

FIG. 3 is an enlarged fragmentary vertical section through sheet feeding and guiding means.

FIG. 4 is an enlarged fragmentary vertical section through sheet folding and gripping components and adjusting means.

FIGS. 5A through 5F are diagrammatic elevational views depicting the method steps employed for folding each sheet.

DETAILED DESCRIPTION

Referring to the drawings in detail wherein like numerals designate like parts throughout the same, the apparatus for folding paper sheets and the like comprises a suitable main frame **20** having a horizontal table top **21** upon which a stack of paper sheets **22** to be folded rests, with the stack positioned by adjustable guide means **23**. Forwardly of the stack **22**, an inclined sheet guide **24** directs the leading edge of each sheet manually fed from the top of the stack through the nips of a power-driven feed roll **25** and coacting presser rolls **26** which are idlers; the presser rolls **26** are journaled on a short arm **27** rigid with a rocker shaft **28**, said shaft having a depending arm **29** rigid therewith, the arm **29** projecting well below the feed roll **25**. A pair of closely spaced vertical sheet guides **30** and **31** are fixedly mounted to receive between them each sheet fed downwardly by the coacting rolls **25** and **26**. A sensing switch **32** suitably mounted on the vertical guide structure has an actuator arm **33** which extends through slots **34** and **35** of the guides **30** and **31** so as to be in the path of movement of each sheet delivered downwardly in the narrow slot **36** between the guides **30** and **31**. The arm **29** also carries tension fingers **37** whose lower tips enter through the slots **34** and **35** and bear against each sheet to lightly tension it during a portion of the operating cycle, as will be fully described.

The apparatus further comprises coacting tucker and gripper assemblies shown in FIGS. **2** and **4** which coact in a unique manner to fold each web or sheet. The tucker assembly shown at **38** includes a pair of arms **39** and **40** disposed in crossing relationship and having their upper ends pivoted, respectively, to the shaft **28** and the shaft **41** of feed roll **25**. The two arms are thus independently pivoted at their tops. They are interconnected near their lower ends by a short link **42** pivoted to the tucker arms at **43** and **44**. At their lower ends, the arms **39** and **40** carry opposing thin tucking and folding blades **45** and **46** which project at right angles to the arms beyond the inner sides thereof. As shown, the blades **45** and **46** are disposed well below the bottoms of the vertical guides **30** and **31**, whose lower arms are flared as at **47**.

Two opposing gripper units **48** and **49** are provided with each unit including an arm **50** and **51** having their upper ends respectively pivoted to the same elements **41** and **28** about whose axes the tucker arms **39** and **40** may swing. The bottoms of the gripper arms **50** and **51** are pivoted to short connecting links **52** and **53**, in turn pivotally connected to adjusting elements **54** and **55** having a connection with a right and left hand threaded screw shaft **56**, by means of which the lower ends of the arms **50** and **51** are moved closer together or more distantly apart to regulate the length of the fold. This is an important feature of the apparatus and method and it is particularly significant that the arms **39** and **40** swing on the same pivots as the arms **50** and **51**. As will be described, the tucker arms **39** and **40** derive their movement from a single crank means whose throw may be varied.

Referring to FIG. **4**, each of the arms **50** and **51** is provided near its lower end with a horizontal bar **57** which spans the apparatus transversely of the paper

sheets and secured to the bottom of each bar 57 by bolt means 58 are a pair of gripper elements or plates 59 and 60 having flared ends 61 to facilitate the entry of the tucker blades 45 and 46 therebetween. Each gripper plate 60 is spring-biased against the blade 59 by coil springs 62 on the bolt means 58. The tension of the springs 62 may be adjusted. It should be mentioned that there is an adjusting screw shaft 56 and associated elements on each side of the apparatus to facilitate accurate and easy adjustment of the arms 48 and 49 and these screw shafts are operated by suitable bevel gearing and crank turning means, not shown.

The means to operate the two tucker arms 39 and 40 comprises a rotating disc 63 having a single crank pin 64 pivoted to a drive link 65 having its opposite end adjustably pivoted at 66 to a vertical oscillating arm 67 having its top end connected with a fixed pivot 68. The lower end of the arm 67 well below the pivot 66 is also pivoted at 69 to a reciprocating link 70 which is substantially horizontal. The remote end of this link 70 is pivoted at 71 to the midpoint of the short link 62 between the two arms 39 and 40. By virtue of this arrangement, turning of the disc 63 causes the tucker assembly 38 to oscillate back and forth in a unique manner as detailed in FIGS. 5A through 5F.

A main motor 72 is provided on the apparatus to operate conventional gearing 73 operatively connected with additional transmission means 74 leading to the feed roll 25 and the rotary disc 63. Suitable clutch means, time delay means, and other conventional controls are embodied in the apparatus to impart the proper sequence of operations to the feed roll 25 and tucker unit 38, and the details of these control means are not essential to a proper understanding of the method and the main apparatus components forming the essence of the invention.

Substantially below the tucker and gripper assemblies, an inclined collection tray 75 is suitably supported on the frame of the apparatus to receive each completely folded paper sheet of whatever length is being processed by the apparatus. Periodically, the folded work may be removed from the tray 75 manually at the near end of the machine.

Referring now to partly diagrammatic FIGS. 5A through 5F, the essence of the method is depicted in a series of steps. The position of the apparatus in FIG. 2 corresponds to FIG. 5A. The tucker assembly 38 is at a center or neutral position between the two gripper support arms 48 and 49 which have been adjusted to produce the desired length of fold. The paper sheet or web W has been advanced manually into the guide 24 and between the nips of the feed roll 25 and presser rolls 26. The power-driven feed roll 25 has fed the web downwardly through the guide passage 36 and the leading end of the web has engaged the sensing switch actuator arm 33 to cause energizing of a time delay means or relay 76, FIG. 2. At this time, the positive feeding of the web W continues until the leading edge of the paper web has passed between the tucker blades 45 and 46 and below the confines of the two guides 30 and 31, FIG. 5A.

The built-in time delay interval has now passed causing activation of a solenoid 77 after a length of paper corresponding to the pre-established fold length has been fed past the tucker blades 45 and 46. The solenoid 77, through a pull link 78, now pulls in levers 79 and 80 accomplishing the following. The presser rolls 26 are lifted from contact with the feed roll 25 by the lever 79 and the positive feeding of the paper is interrupted. Simultaneously, the tension fingers 37 are brought into light holding contact with that portion of the web between the guides 30 and 31. The tucker or folding unit 38, now at the neutral position, FIG. 5A, is set into motion by the movement of the lever 80 by releasing a clutch trip 81 and raising a crank positioner 82 which allows the disc 63 with crank pin 64 to begin revolving.

When the above occurs, the linkage associated with the crank pin 64 will swing the tucker assembly 38 toward the position shown in FIG. 5B where the right hand tucker blade 45 begins to engage the web W and push the web toward the relatively stationary left hand gripper assembly 49 having a pair of the blades 59 and 60.

FIG. 5C depicts further movement of the tucker unit in the same direction and shows the tucker blade 45 tucking the paper web between the spring-loaded gripper plates or jaws 59 and 60 as the blade 45 nears the extreme of its swing to the left.

In FIG. 5D, the tucker assembly 38 has reversed its stroke under influence of the crank operated linkage and the right hand blade 45 has slipped out of the left hand gripper unit leaving the folded web firmly clamped between the plates or jaws 59 and 60 of the left hand gripper unit. The left hand tucker arm 40 with its tucker blade 46 now begins pushing the paper web toward the right hand gripper unit and the paper web is now drawn downwardly from the top by the action of the moving tucker assembly, the tension fingers 37 exerting a light retarding action on the paper.

In FIG. 5E, the left hand tucker blade 46 has now advanced the web into the right hand gripper jaws and the paper web breaks around the leading edge of the tucker blade. This prevents the web from slipping around the edge of the blade and transfers a pull or tension to the portion 83 of the web stretched between the tucker blade 46 and the left hand gripper jaws 59 and 60. Continued movement of the tucker assembly 38 to the right in FIG. 5E will pull the folded web entirely out of the left hand gripper and tuck the next fold firmly into the right hand gripper. The previously folded portion simply falls into the delivery tray 75. At this point, the web is held by the right hand gripper as depicted in FIG. 5F and following this the tucker assembly will begin to return toward the left and the right hand tucker blade 45 will begin to push the web to the left in the same manner previously shown in FIG. 5B. The folding cycle is repeated automatically until the web of whatever length is completely folded in a zigzag fashion.

When the trailing end of the web disengages the sensing switch actuator arm 33, the solenoid 77 is de-energized. The tucker arms 39 and 40 and their blades will come to rest at the center or neutral position and the presser rolls 26 will again engage the web and the positive feed roll 25 will again positively feed the next web or sheet which is advanced manually into it. When the solenoid 77 is de-energized, the link 78 shifts to the left in FIG. 2 and the levers 79 and 80 swing to the left for reactivating the presser rolls 26 and moving the crank positioner 82 back to its position for stopping the

crank element 64. The clutch trip 81 is now returned to its normal position.

It may further be noted that the time delay relay 76 is linked with the right hand gripper arm 48 by a link 84 and a crank arm 85. Therefore, adjustment of the gripper arms 50 and 51 in either direction by the screw shaft means 56 also adjusts the time delay interval automatically so that the components of the apparatus are properly cycled regardless of the preselected length of fold which can be varied over a wide range. A main advantage of the construction is that the width of the web which can be folded is not restricted and can be almost any dimension within reason. Relatively few parts are involved and the unique coaction of the tucker blades 45 and 46 with the gripper jaws or plates 59 and 60 accomplish the folding and the feeding of the web while the feed roll 25 is inactive and also the release of the web from the grippers automatically without the need of separate web dislodging means. The apparatus has a wide range of adjustment.

It may also be observed in FIGS. 5A through 5F that as the tucker assembly 38 swings back and forth to the left and right that the blades 45 and 46 are also elevated and lowered with a stepping action by virtue of the linkage so that the inactive tucker blade will always be clear of the web and clear of the active blade.

It is also contemplated under the invention to fold a paper web fed from a supply roll instead of a stack of individual sheets, as described. The exact mechanism of the invention can accomplish this end when suitable supporting and unwinding control means for a supply roll is provided adjacent to the table top 21.

It is to be understood that the form of the invention herewith shown and described is to be taken as a preferred example of the same, and that various changes in the shape, size and arrangement of parts may be resorted to, without departing from the spirit of the invention or scope of the subjoined claims.

I claim:

1. A method of folding sheets of paper and the like comprising positively feeding individual sheets into a substantially vertical guide passage and frictionally engaging each sheet in the guide passage and discontinuing the positive feeding so that each sheet is substantially free-hanging under light frictional retarding, engaging one side of the hanging sheet with a first tucker blade and pushing the sheet into a first gripper to thereby form a first transverse fold in the sheet, the first gripper then holding the sheet at the first fold, causing the first tucker blade to disengage the sheet held by the first gripper and then engaging the other side of the sheet with a second tucker blade and pushing the sheet into a second gripper while simultaneously drawing the sheet downwardly and overcoming the frictional retarding of the sheet and thereby forming a second transverse fold in the sheet, the movement of the second tucker blade into the second gripper withdrawing the first fold from the first gripper, and then causing the second tucker blade to disengage the sheet held by the second gripper and then repeating the method steps until the folding of the sheet is completed throughout its length.

2. The method as defined in claim 1, and causing said first and second tucker blades to swing back and forth between the first and second grippers on arcuate paths coincident with arcs on which the grippers are disposed.

3. The method as defined in claim 2, and causing the first and second tucker blades to alternately rise and fall during their arcuate movement toward and away from the first and second grippers.

4. The method as defined in claim 1, and causing the first and second grippers to resiliently and releasably grip the folded sheet.

5. A sheet folding apparatus comprising in combination means to receive sheets individually and to deliver them to a substantially vertical hanging position where each sheet is lightly held frictionally, a pair of opposed grippers on opposite sides of each hanging sheet, each gripper consisting of a pair of opposed gripper plates and spring means resiliently urging the plates into yielding clamping contact, a swingable tucker unit between said grippers including a pair of opposed tucker blades each adapted to enter between the opposed gripper plates of one of said grippers to produce a fold in each sheet, one tucker blade disposed on each side of each hanging sheet, linkage means connected with said tucker unit to swing the unit in opposite directions relative to the sheet and between the opposed grippers so that each tucker blade in turn engages one side of each sheet and forces the sheet between the opposed tucker blades of the opposing gripper to form a fold in said sheet, said linkage means producing movement of the other previously inactive tucker blade with said sheet between the opposed gripper plates of the other previously inactive gripper to form another fold in said sheet and in so doing tensioning the sheet and withdrawing it from between the gripper plates of the gripper in which the sheet was previously folded, and a connection between said tucker blades causing them to rise and fall relatively and relative to the grippers during swinging movement of the tucker unit.

6. The structure as defined in claim 5, and said swinging tucker unit comprising a pair of crossing individually pivoted arms, said opposed tucker blades carried by the lower ends of the arms, and said connection comprising a link pivotally interconnecting the arms and having a pivotal connection between the arms with said linkage means.

7. The structure as defined in claim 6, and said linkage means including a rotary member having a single crank element.

8. The structure as defined in claim 7, and said opposed grippers including gripper arms having their upper ends pivoted to the same elements which pivotally support said arms of the tucker unit, and means to adjust the lower ends of the gripper arms toward and from each other on an arc around said pivot elements.

9. The structure as defined in claim 8, and a pair of gripper plates on the lower end portion of each gripper arm with one plate of each pair resiliently urged toward the other plate.

10. A sheet folding apparatus comprising a support for a stack of sheets to be folded, a power-operated feed roll on the support in advance of the stack and adapted to engage and feed individual sheets fed manually from the stack toward the feed roll, a cooperating presser roll bearing on the feed roll and being movably supported, means forming a substan-

tially vertical guide passage for each sheet below the feed roll, an element mounted to move with the presser roll and adapted to frictionally engage each sheet in the vertical guide passage and support the sheet when the presser roll is moved away from the feed roll to interrupt the positive feeding of the sheet, a sensing element projecting into said guide passage and responding to engagement with the leading and trailing edges of each sheet to initiate movement of the presser roll away from the feed roll and to start a sheet feeding cycle after a preset time delay interval and to terminate the folding cycle and again move the presser roll into engagement with the feed roll, a pair of opposed relatively fixed resilient gripper devices arranged on opposite sides of each sheet in the vertical guide passage, a pair of cooperating opposed tucker blades swingably mounted between the gripper devices and arranged on opposite sides of each sheet in said vertical guide passage, power driven linkage means connected with the tucker blades to oscillate the same between the gripper devices and to cause rising and falling of the tucker blades alternately as they oscillate between the gripper devices, whereby one tucker blade engages one side of each sheet and forces the sheet into one gripper device to produce a first fold in the sheet, followed by the other tucker blade engaging the opposite side of each sheet and forcing the sheet into the second gripper device to produce a second fold in the sheet and in so doing pulling the sheet out of the first gripper device.

11. The structure as defined in claim **10**, and a power-operated device activated by the sensing element to substantially simultaneously shift the presser roll away from the rotating feed roll and to move said element into frictional engagement with the sheet in said guide passage and to activate said cooperating tucker and gripper devices for a predetermined cycle.

12. The structure as defined in claim **11**, and said power-operated device including a solenoid.

* * * * *