FOLDING APPARATUS

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ABSTRACT

Folding apparatus for use in folding a sheet, particularly for folding the sheet into a signature. A travelling sheet is folded once by a first folder, and while continuing to travel in a straight path is folded in a second folder along a line parallel to the direction of travel by a diagonal cross over guide. While continuing to travel in the same direction, the sheet is folded again by a third folder to produce a signature.

10 Claims, 15 Drawing Figures
FOLDING APPARATUS

BACKGROUND OF THE INVENTION

One of the most common types of folders for paper has rollers which cooperate with ramps to buckle the paper along a fold line with the buckled portion then passing between rollers to complete the fold. Paper is often folded into a signature, particularly in printing a book, pamphlet or the like. This requires that folds be made in different directions, that is, both longitudinally and transversely of a sheet, so that more than one folder is required. Sometimes three folders are used, the first folder serving to make a fold along a transverse fold line across the sheet, the second folder then making a second fold along a longitudinal fold line, and the third folder making still another fold, again along a transverse fold line. With this arrangement, however, it is necessary to change the direction of travel of the sheet as it passes through the three folders in successive order. The sheet travels through the first folder in a first direction, then makes a right angle turn and passes through the second folder to produce the longitudinal fold, and then changes direction again to pass through the third folder in the first direction. It is desirable to feed sheets rapidly through the series of folders to maximize production in a folding operation. However, where the sheet must change directions in the manner just described, the sheet must be turned out of the way of the next successive sheet before that latter sheet can be fed into the second folder. Consequently, in passing through the series of folders, the sheets are spaced apart from each other enough to allow one sheet to change direction and get out of the way of the next sheet before it reaches the point where the direction of travel changes. As previously mentioned, this slows down the folding operation.

SUMMARY OF THE INVENTION

In the folding apparatus of the present invention, a sheet is folded along a longitudinal line without changing the direction of travel of the sheet by a guide means which extends diagonally relative to a holder under which a portion of the sheet travels. The guide lifts one side of the sheet and forces it over and down onto the other side of the sheet while the sheet is moving. The action of the guide may be supplemented by flowing air. It is also sometimes desirable to weaken the sheet along the longitudinal fold line before the fold is made, and this may be accomplished with a perforator or other weakening means. This folder is preferably used as the second stage in a three stage folding system, the first and third stages being conventional and both serving to fold the sheet along a transverse fold line in the manner described previously. The sheet travels in the same general direction through the entire folding system, and since the change of direction of the sheet is involved, the space between successive sheets can be minimized to speed up production.

BRIEF DESCRIPTION OF THE DRAWINGS

FIG. 1 is an elevational view of a folding system;
FIG. 2 is a plan view of the second stage or section of the folding system which in itself constitutes a folder;
FIG. 3 shows a sheet after it has been folded once by the first folder of the system and then perforated along a line which is to be the second or longitudinal fold line;
FIG. 4 is a sectional view taken along line 4—4 of FIG. 2;
FIG. 5 is a sectional view taken along line 5—5 of FIG. 2;
FIG. 6 is a sectional view taken along line 6—6 of FIG. 2;
FIG. 7 is a sectional view taken along line 7—7 of FIG. 2;
FIG. 8 is a plan view of the second folder or folding stage illustrating the action of a crossover guide in folding a sheet along a longitudinal fold line;
FIG. 9 shows the sheet after the second fold has been made;
FIG. 10 is a plan view of the second folder or folding stage illustrating the action of a crossover guide in folding a sheet along a longitudinal fold line;
FIG. 11 is a plan view of another modification of the folder;
FIG. 12 illustrates the action of flowing air in supplementing the crossover guide included in the folder of FIG. 11;
FIG. 13 further illustrates the action of the crossover guide in the embodiment of FIG. 11;
FIG. 14 is a plan view of a folder which forms still another embodiment of the invention; and carried out;
FIG. 15 illustrates the action of the folder of FIG. 14.

Before explaining the present invention in detail, it is to be understood that the invention is not limited in its application to the details of construction and arrangement of parts illustrated in the accompanying drawings, since the invention is capable of other embodiments and of being practiced or carried out in various ways. Also, it is to be understood that the phrasing or terminology employed herein is for the purpose of description and not of limitation.

AS SHOWN ON THE DRAWINGS

Referring first to FIG. 1, a three stage folding apparatus is shown including a first folder 20, a second folder 22 and a third folder 24. A sheet of paper or other like material passes through the three folding stages in the direction of the arrow. There is no change in direction of the sheet as it travels. The first folder 20 folds the sheet once along a transverse fold line, and the resulting folded sheet 26 is shown in FIG. 3. This particular sheet has been perforated at 28 along a line which is to become a longitudinal fold line as will be described further. After the sheet has been folded once, it passes through the second folder 22 which folds the sheet 26 along the perforated line 28 without changing the direction of travel of the sheet. The resulting twice-folded sheet 26 is shown in FIG. 9. Then the sheet goes to the third folder 24 which folds it along another transverse fold line to produce a signature of the type commonly used in the printing trades.

The first folder 20 and the third folder 24 are completely conventional, and these folders will not be described herein since they are readily commercially available. They may be of the type which include rollers cooperating with ramps and wherein the sheet passes up a ramp to a stop, after which the sheet buckles and the buckled portion passes between rollers to produce the fold.

Referring to FIGS. 1 through 9, the second folder 22 is shown in more detail. It has conveyor belts 30, 32 and 34 driven by a drive shaft 36 and an idler shaft 38. A motor and belt drive system are indicated diagrammatically at 40 and serve to drive the shaft 36 and thus drive the belts 30, 32 and 34 in the direction of the arrows. The paper is guided by an adjustable side rail 29. The drive system 40 also drives another shaft 42 on which a toothed perforating disk 44 is mounted along with other guiding disks 46. There is a backing roll 45 under disk 44. The shaft 42 and disks 44 and 46 may be mounted either on the frame 48 of the second folder 22 or may be included in the first folder 20, if desired. Mounted on a crossbar 50 are holders 52, 54 and 56 under which one side of the paper sheet 26 is transported by the belts 30, 32 and 34. Holder 52 is attached to bar 50 by a screw 53. The two holders 54 and 56 are in the form of bars suspended from posts 58 and 60 which are attached to the crossbar 50 as by means of a set screw 52. The bars 54 and 56 have openings in which balls 64 and 66 are confined loosely such that the balls will ride on the paper 26 as it travels through the folder to hold down the underlying portion of the paper.

The other holder 52 is in the form of a resilient band, one end of which is attached as with a screw to the crossbar 50. The band 52 simply curves down toward the belt 30 and rides on top of the sheet 26 as it travels through the folder. The holder 52 serves as a straight edge located at a central portion of the folder and it may be noted that the perforating disk 44 is lined up with the edge of the holder 52. Thus, when the longitudinal fold is made, the paper folds across the holder 52 along the line of weakening 28. Folding is accomplished primarily by a crossguide 70 which extends diagonally relative to the holder means 52, 54 and 56 from a point at 72 up and diagonally toward the holders. In this embodiment, the crossguide 70 extends almost fully across the width of the folder and is affixed to the opposite side of the frame 48 by a set
screw 74. It may be seen that the crossguide 70 in this embodiment is a band which twists one-half turn. The sheet 26 rides over the leading edge 72 of the band 70 and is lifted by the band 26 and pushed over against the edge of the holder 52 and then down on the underside of the sheet to complete the fold.

The action of the crossguide 70 is shown particularly in FIGS. 7 and 8. As shown there, the free side of the sheet 26 initially rides up the upwardly slanting portion of the crossguide 70, and the sheet in this position is designated 26a. As the sheet progresses, it reaches the position where it is designated 26b. The sheet 26b has been partially folded along the line of weld 28 against the holder 52. When the sheet progresses to the position where it is designated 26c, the far end of the crossguide 70 is forcing the free portion of the sheet down on the retained portion thereof to complete the fold. The sheet is also travelling out from underneath the holders 52, 54 and 56. This final downward folding of the sheet is aided by an air jet supplied from a nozzle 80, the jet being directed at the top side of the partially folded sheet. When the sheet reaches the position where it is designated 26b, it has been completely folded and is emerging from the second folder 22 and passing into the third folder 24.

The crossguide 70 is capable of folding the sheet without the assistance of the air jet 80 but the cooperative action of the crossguide 70 and the air jet 80 is not necessary.

FIG. 10 shows a modification of the embodiment of FIGS. 1-9, the only difference being that the crossguide 90 is in the form of a rod or wire rather than a band. Since this is the only difference in the two embodiments, the same reference numerals have been used for like parts, and the operation of the apparatus is exactly the same as described previously.

FIG. 11 shows another modification wherein the crossguide 100 is a tube from which air is directed on the paper to assist in the folding action. The tube 100 has openings such as the openings 102 and 104 shown in FIGS. 12 and 13. The openings 102 towards the leading end of the crossguide 100 direct air sideways and somewhat upwards to lift the free side of the paper sheet 26 in the manner shown for example at 26b. The openings 104 towards the trailing edge of the crossguide 100 direct air downwardly to assist in folding the sheet down as shown at 26c. Of course, the air jet in this embodiment is incorporated into the crossguide 100 so that no separate air jet is needed. In all other respects, the apparatus of FIG. 11 is identical to that of FIGS. 1 through 9 so the same reference numerals have been used for like parts.

Still another embodiment of the invention is shown in FIGS. 14 and 15. In this embodiment, the crossguide 110 is a belt, but the belt moves since it is driven by a shaft 112 connected to the power train of the apparatus. In all other respects, the embodiment of FIGS. 14 and 15 is identical to that of FIGS. 1-9, so the same reference numerals have been used for like parts.

The action of the crossguide 110 is very similar to that described previously and is illustrated in FIG. 15. The sheet at 26a is lifted by the belt 110, and by the time the sheet reaches the position where it is designated 26b it is partially folded toward the holder 52. The far end of the belt 110 is looped around a roller 114 on an arm 116, so it is similar to the crossguides described previously in that it extends diagonally relative to the holders from a point to one side of the holders up and towards the holders. In this embodiment, the air jet 80 completes the folding which is started by the crossguide 110. When the sheet reaches the position where it is designated 26c, it has been blown down toward the retained portion thereof by the air jet 80. The fully folded sheet is shown at 26d as it emerges from the second folding stage.

Thus, the invention provides folding apparatus including particularly a folder wherein a longitudinal fold is made by a crossguide which may be supplemented by flowing air. This folder may be part of a complete system including a first folder which folds a sheet along a transverse fold line, the second folder including a crossguide which folds the sheet along a longitudinal fold line, and a third folder which again folds the sheet along a transverse fold line. The sheet travels in a generally straight path through all three folders, so sheets can follow each other closely to maximize production.

Having thus described our invention, we claim:

1. A folding apparatus in which a sheet travels through plural folding sections to produce a signature without substantial change in a generally horizontal path of the travelling sheet, said apparatus comprising a first folder through which said sheet travels in a first direction and is folded along a fold line transverse to said first direction, a second folder receiving said sheet from said first folder, said sheet travelling through said second folder wholly in said first direction, said second folder including holder means under which one side portion of said sheet travels and having a straight edge surface extending longitudinally in said first direction toward which the other side portion of said sheet may be folded, and a fixed crossover guide extending diagonally in the direction of travel and in a 180° arc relative to said holder means from a point below and to one side thereof corresponding to said other side of said sheet up and diagonally in the direction of travel across the holder means and down generally to the level of the holder means on the opposite side of the holder means to lift said other side portion of said sheet and fold the said sideways and down against said straight edge surface along a longitudinal fold line which contacts said said straight edge surface, and a third folder through which said sheet travels in said first direction and is folded again along a fold line transverse to said first direction, thereby producing a signature, said first and second and third folders lying generally in the same horizontal plane.

2. The apparatus as claimed in claim 1 including sheet distortion means ahead of said guide to weaken said sheet along said longitudinal fold line.

3. The apparatus as claimed in claim 1 in which said guide comprises a twisted band.

4. The apparatus as claimed in claim 1 including means for directing air on the lifted portion of the sheet to assist in producing the fold.

5. The apparatus as claimed in claim 4 in which said guide is hollow and has at least one opening through which air may be directed on said sheet.

6. The apparatus as claimed in claim 4 in which said air directing means is separate from said guide.

7. The apparatus as claimed in claim 1 in which said guide comprises a rod.

8. Folding apparatus in which a sheet travels through plural folding sections to produce a signature without substantial change in a generally horizontal path of the travelling sheet, said apparatus comprising a first buckle folder through which said sheet travels in a first direction and is folded along a fold line transverse to said first direction, a second folder receiving said sheet from said first folder, said sheet travelling through said second folder wholly in said first direction, said second folder including holder means under which one side portion of said sheet travels, said holder means having a straight edge surface extending longitudinally in said first direction toward which the other side portion of said sheet may be folded, a perforating disk retained in longitudinal alignment with said straight edge surface ahead of said surface to perforate said sheet along said longitudinal fold line, and a fixed crossover guide band extending diagonally in the direction of travel in a 180° arc relative to said holder means from a point below and to one side thereof corresponding to said other side of said sheet up and diagonally across said holder means and down generally to the level of said holder means on the opposite side of said holder means to lift said other side portion of said sheet and fold the said sideways and down against said straight edge surface along a longitudinal fold line which contacts said said straight edge surface, said crossover guide band twisting through part of a revolution in traversing said holder means, and a third buckle folder through which said sheet travels in said first direction and is folded again along a fold line transverse to said first direction, thereby producing a signature, said first and second and third folders lying generally in the same plane.
9. Folding apparatus in which a sheet travels through plural folding sections without substantial change in a generally horizontal path of the travelling sheet, said apparatus comprising a first folder through which said sheet travels in a first direction and is folded along a fold line transverse to said first direction, a second folder receiving said sheet from said first folder, said sheet travelling through said second folder wholly in said first direction, said second folder including holder means under which one side portion of said sheet travels and having a straight edge surface extending longitudinally in said first direction toward which the other side portion of said sheet may be folded, and a hollow crossover guide rod extending diagonally in the direction of travel relative to said holder means from a point below and to one side thereof up and diagonally across the holder means and down generally to the level of said holder means on the other side of said holder means to lift said other side portion of said sheet and fold the same sideways against said straight edge surface along a longitudinal fold line, said hollow guide rod having at least one opening therein through which air may be directed on said lifted portion of said sheet to assist the folding thereof, and a third folder through which said sheet travels in said first direction and is folded again along a fold line transverse to said first direction, thereby producing a signature.

10. The apparatus as claimed in claim 9 in which said hollow guide rod has a plurality of said openings arranged in a spiral pattern.

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