WEB FOLDING APPARATUS

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ABSTRACT

A machine for producing V-folds and then C-folds in each of a plurality of webs and for advancing the webs in a continuously moving stack. The V-folds are formed by directing the webs over generally triangular folding elements, while the C-folds are formed by advancing the V-folded webs along folding elements which are each provided with a pair of folding fingers of rectangular cross-section. The folding fingers have inwardly directed folding surfaces which converge in the direction of movement of the webs and engage separate longitudinal portions of the webs to produce the C-fold.

6 Claims, 15 Drawing Figures
WEB FOLDING APPARATUS

BACKGROUND OF THE INVENTION

This invention relates to folding apparatus and more particularly to apparatus for forming longitudinal folds in a plurality of webs and for advancing the webs in a continuously moving stack.

The present invention, while of general application, is particularly well suited for use in this tissue field. In the manufacture of towels, facial tissue and similar tissue products, the tissue commonly is folded in a long stack built up from a large number of separate tissue webs, one for each sheet in the package. As the webs approach the stack, they pass along a series of folding elements which produce one or more longitudinal folds in each web. The folding elements customarily include folding edges or surfaces which cooperate with guide members to direct the webs along predetermined paths in accordance with the desired type of fold. The assembled stack of webs is cut off into convenient lengths which are then packaged for use by the consumer. For a more detailed discussion of representative known techniques for folding tissue webs, reference may be had to U.S. Pat. No. 2,642,279 granted June 15, 1953, U.S. Pat. No. 3,285,599 granted Nov. 15, 1966, U.S. Pat. No. 3,472,504 granted Oct. 14, 1969, and U.S. Pat. No. 3,542,356 granted Nov. 24, 1970.

Heretofore, difficulties were encountered in the formation of longitudinal folds in a succession of webs. As an illustration, many types of folding machines previously employed were not readily adaptable for the production of folds of C-shaped cross-section. In addition, and this has been of special moment in cases in which the individual folding elements on the machine included a plurality of folding edges, it often was difficult to maintain the guide members for the webs in proper relationship with the edges. Furthermore, problems were frequently encountered, in prior web folding machines, in producing the desired folds without unwanted wrinkles or creases in the webs.

SUMMARY

One general object of this invention, therefore, is to provide new and improved apparatus for forming longitudinal folds in a succession of webs.

More specifically, it is an object of this invention to provide such apparatus in which the folded webs are of C-shaped cross-section.

Another object of this invention is to provide apparatus of the character indicated in which the individual guide members for the webs are maintained in proper relationship with the folding elements at all times.

A further object of the invention is to provide web folding apparatus utilizing comparatively simple mechanical elements which is economical to manufacture and thoroughly reliable in operation.

In one illustrative embodiment of this invention, there is provided an apparatus for forming longitudinal folds in a series of webs and for advancing the webs in a continuously moving stack. The webs are directed from suitable supply rolls to a first group of folding elements positioned in spaced relationship with the path of the stack. These folding elements are effective to form longitudinal median fold in each web. The webs are then led to a second group of folding elements, one for each web, which are located along the path of the stack in spaced relationship with each other. Each of the folding elements in this latter group includes an infeed portion angularly disposed with respect to the stack and a substantially flat outfeed portion. As each web moves along the infeed and outfeed portions of its folding element, the longitudinal edge portions of the web are simultaneously turned over the adjacent edges of the folding element to form a fold of C-shaped cross-section.

In accordance with one feature of the invention, each of the folding elements in the second group includes a pair of folding fingers of substantially rectangular cross-section which overlie the outfeed portion of the folding element. The rectangular fingers provide a positive guide for the longitudinal portions of the web to insure the formation of an extremely well-defined C-shaped fold.

In accordance with another feature of the invention, in certain preferred embodiments, the pairs of folding fingers are maintained in fixed relationship with their folding elements at all times. The fingers for each folding element are mounted on a novel supporting structure and are positioned in precise relationship with the outfeed portion of the element. Among its other advantages, this arrangement greatly simplifies the setting up of the machine and insures that successive folds are of identical configuration.

In accordance with still another feature of the invention, in several good arrangements, the apparatus includes unique means for creasing the C-folded webs as they enter the stack. In some cases the webs also are creased following the formation of the median fold by the first group of folding elements. The arrangement is such that each web is substantially flat as it enters the second group of folding elements and also as it reaches the stack. As a result, there is a substantial reduction in the incidence of unwanted creases and wrinkles in the web.

BRIEF DESCRIPTION OF THE DRAWINGS

The present invention, as well as further objects and features thereof, will be understood more clearly and fully from the following description of certain preferred embodiments, when read with reference to the accompanying drawings, in which:

FIG. 1 is a side elevational view of a machine for folding a plurality of tissue webs into a stack of webs in accordance with one illustrative embodiment of the invention, with certain portions shown broken away and other portions omitted for purposes of clarity;

FIG. 2 is a vertical sectional view taken along the line 2--2 in FIG. 1, with portions of a tissue web shown in broken lines;

FIG. 3 is a side elevational view of one of the folding elements of the machine and the tissue web, as seen from the line 3--3 in FIG. 2;

FIG. 4 is a bottom plan view of the folding element and tissue web of FIG. 3, as seen from the line 4--4 in that figure;

FIG. 5 is a top plan view of the tissue web shown in FIG. 4;

FIG. 6 is an enlarged vertical sectional view of the tissue web taken along the line 6--6 in FIG. 3;

FIG. 7 is a top plan view of the folding element shown in FIG. 3, together with portions of the supporting structure;
FIG. 8 is a fragmentary vertical sectional view taken along the line 8—8 in FIG. 7;
FIGS. 9, 10 and 11 are transverse vertical sectional views respectively taken along the lines 9—9, 10—10 and 11—11 in FIG. 7, with certain parts omitted and with the tissue web shown in broken lines;
FIG. 12 is an enlarged horizontal sectional view taken along the lines 12—12 in FIG. 3, with the tissue web omitted to show the structure;
FIG. 13 is a fragmentary perspective view of one of the folding fingers on the folding element shown in FIG. 3;
FIG. 14 is a bottom plan view of a folding finger unit useful in connection with another illustrative embodiment of the invention; and
FIG. 15 is a rear elevational view of the unit of FIG. 14 as seen from the line 15—15 in that Figure.

DESCRIPTION OF CERTAIN PREFERRED EMBODIMENTS

Referring to FIG. 1 of the drawings, there is shown a machine for forming identical longitudinal folds in each of a plurality of tissue webs 20 and for assembling the webs one on top of the other in a continuously moving stack 21. The webs 20 are led to the machine from suitable supply rolls (not shown) which may be located along a single side of the stack 21 in a manner similar to that disclosed in copending U.S. Pat. application Ser. No. 114,994 filed Feb. 12, 1971 by Charles A. Lee, Warren R. Furbeck and Horace N. Kemp. The webs are advanced in their unfolded condition to a first group of folding elements indicated generally as 22, one of the elements 22 being provided for each web. In a manner that will become more fully apparent hereinafter, each of the folding elements 22 is effective to form a longitudinal median fold 23 in the corresponding web, such that the cross-section of the web resembles the letter "V". The V-folded web is creased as it passes through the nip between two rollers 24 and 25 located on the outfeed side of the folding element. The longitudinally folded webs proceed toward the stack 21 and are respectively received by a second group of folding elements 30. The webs are directed along the folding elements 30, and the longitudinal edge portions of each web are engaged by two folding fingers 31 and 32 (FIG. 12) of rectangular cross-section. The fingers 31 and 32 are effective to turn the edge portions of the web over the adjacent portion of the folding element to thereby form a C-shaped fold. As the C-folded web reaches the path of the stack, it is creased by a roller 34 adjacent the outfeed side of each folding element. As will be understood, the assembled stack is cut by a suitable saw mechanism (not shown) into convenient lengths which are packaged in wrappers or paperback boxes.

The first group of folding elements 22 is suspended in spaced relationship with the path of the stack 21 from a horizontal beam 37. The beam 37 extends parallel to and a short distance above the stack and is suitably supported on the machine by upstanding brackets 38. Each of the elements 22 comprises a triangular folding board 40 having two intersecting folding edges 41 and 42 of equal length on the side of the board facing the stack. As best shown in FIG. 2, the remaining edge 43 of each folding board extends horizontally adjacent the upper portion of the beam 37 and is affixed to the beam by a resilient clip 44 held in place by bolts 45. The board extends downwardly from the clip 44 at an acute angle with respect to the horizontal.

A channel-shaped beam 47 is spaced beneath the beam 37 and similarly is supported by the brackets 38. The beam 47 carries an angle member 48 along its upper surface, and the angle member supports a series of threaded rods 50, one for each of the folding boards 40. Each rod 50 is adjustable in a horizontal direction by means of nuts 51, and the rod carries a clevis 53 at the end of the rod adjacent the corresponding folding board. This clevis is pivotally secured to a mounting plate 54 affixed to the central portion of the board. The arrangement is such that the angular position of the board relative to the tissue stack 21 may be readily adjusted by rotating the nuts 51 to move the rod 50 in an axial direction. During this movement, the clip 44 at the upper edge 43 of the board flexes slightly while continuing to provide the requisite support.

Each of the creasing rollers 24 and 25 is carried by a shaft bracket 56 mounted on the vertical face of the beam 47. The rollers 24 and 25 are positioned on the outfeed side of the board 40 immediately beneath the apex of the angle formed by the intersecting folding edges 41 and 42. The rollers define a nip 57 therebetween in position to receive the tissue web 20 as it leaves the board.

The folding elements 30 in the second group are located in spaced relationship with each other along the path of the stack 21 beneath the respective nips 57. Each of the folding elements 30 includes an angular casting 60 having an infeed portion 61 and an outfeed portion 62. The portions 61 and 62 are of generally flat, plate-like configuration and intersect one another along a line 63 which extends transversely with respect to the stack 21. The infeed portion 61 lies in a plane which meets the plane of the stack at a substantial acute angle, while the outfeed portion 62 is located in a plane which meets the stack at a much smaller angle. As best shown in FIGS. 9—12, the portion 62 is provided with a pair of parallel rounded folding edges 65 and 66.

The infeed portion 61 of each of the castings 60 (the right end, as viewed in FIG. 7) includes two integrally formed ears 67 and 68. These ears support a roller 70 which is arranged directly beneath the nip 57 in position to receive the web 20 therefrom. A ledge 72 also is integrally formed with the infeed portion 61, and affixed to the ledge, as by bolts 73, is a transversely extending arm member 74. The arm members 74 for all of the folding elements 30 are mounted along a single side of the stack 21 on stationary brackets 76 (FIG. 2). The position of each arm member 74 on its bracket, and hence the position of the folding element relative to the stack, is readily adjustable through the use of a knurled knob 77.

Protruding from the upper surface of the outfeed portion 62 of each casting 60 is a second integrally formed ledge 80. The ledge 80 is contiguous with a vertical stiffening web 82 and is provided with an upper surface parallel to the plane of the portion 62. This surface supports a flat mounting plate 85 for the folding fingers 31 and 32. The plate 85 is of hexagonal configuration and is fixedly but removably secured to the ledge 80 by bolts 86. The plate 85 includes four notches or recesses 88 around its periphery which extend inwardly from the two forwardly converging edges of the plate.
Each of the recesses 88 accommodates an upstanding threaded pin 90. The lower ends of the two pins 90 in the recesses adjacent one side of the plate 85 are affixed to the folding finger 31, while the lower ends of the two pins 90 in the recesses adjacent the other side of the plate are affixed to the folding finger 32. Each pin is held in place relative to the plate 85 by a pair of locking nuts 92.

The mounting plate 85, the pins 90 and the nuts 92 serve to hold the folding fingers 31 and 32 in precise spaced relationship with the outfeed portion 62 of the folding element 30. In assembling the element 30, the plate 85 is bolted either directly to the ledge 80 or to an intervening spacer block (not shown), and the nuts 92 are then adjusted to locate the fingers 31 and 32 in the desired positions in a manner that will become more fully apparent hereinafter. Thereafter, and prior to the tissue folding operation, the nuts 92 are welded in place within their recesses 88, as at 94, to positively prevent further movement of the fingers relative to the outfeed portion.

As best shown in FIGS. 12 and 13, the folding fingers 31 and 32 are in the form of elongated bars of rectangular cross-section. The fingers 31 and 32 include inwardly directed folding surfaces 96 and 97 which converge in the direction of movement of the stack 21. Throughout the major portion of their length the surfaces 96 and 97 extend in converging vertical planes, but the surfaces are cut away adjacent the outfeed ends of the fingers to provide upstanding parallel portions 98 and 99, respectively. In addition, the opposite or rearwardly directed portions of the surfaces 96 and 97 include bevels 103 and 104. These bevels are located adjacent the infeed portion 61 of the folding element 30 and, as best seen in FIG. 9, extend in upwardly diverging planes.

The creasing roller 34 (FIGS. 1 and 2) is located immediately adjacent the outfeed end of each of the folding elements 30. The roller 34 is supported on a transversely extending shaft 106 which is mounted on a bracket 107. This bracket is located immediately adjacent the bracket 76 for the folding element support arm 74.

The brackets 76 and 107 are mounted on the usual table 110 of the machine. The table 110 is provided with a longitudinal opening 111 beneath the various folding elements 30 which accommodates an endless conveyor belt 112. As more fully explained in connection with U.S. application Ser. No. 114,994 referred to above, the conveyor belt is continuously driven at a uniform speed to direct the tissue webs 20 past the various folding elements and along the path of the stack 21.

In setting up the machine for the folding of the tissue webs 20, it is important that the height, angle and lateral position of each of the folding fingers 31 and 32 relative to the corresponding folding device 30 be preset to insure the folding of the webs with optimum smoothness. Such presetting is accomplished by adjusting the locking nuts 92 to vary the position of each folding finger relative to the mounting plate 85. In several advantageous embodiments, good results are achieved by locating the folding fingers such that their folding surfaces 96 and 97 each form an angle of twenty degrees with respect to the corresponding edge 65 or 66 on the outfeed portion 62 of the folding device. The height or vertical separation between the lower surface of each folding finger and the upper surface of the outfeed portion 62, as well as the minimum lateral separation in the transverse direction between the bevels 103 and 104 on the fingers and the adjacent edges of the infeed portion 61, depend in large measure on the thickness or bulk of the webs being folded. In the manufacture of towels and other comparatively heavy tissue products having a bulk rating of from about 60 to about 100, however, particularly advantageous results are realized by maintaining such vertical and lateral separation within the range of from about .090 inches to about .100 inches. When the desired separation is achieved, the locking nuts 92 are welded in place in the manner described above to maintain the folding fingers in fixed relationship with the folding element portions 61 and 62.

In operation, the tissue webs 20 are drawn by the conveyor belt 112 from the individual supply rolls past the folding elements 22 and 30. As the webs 20 in their unfolded condition reach the elements 22 and move along the folding board 40, they are longitudinally bisected by the apex of the angle between the folding edges 41 and 42 to form the longitudinal median folds 23. The webs proceed through the nips between the pairs of rollers 24 and 25 to crease the folds 23.

The longitudinally folded webs 20 continue their movement from the rollers 24 and 25 to the infeed rollers 70 on the folding elements 30. As each web 20 passes around its roller 70 and along the corresponding folding element, the edge portions 20a and 20b (FIG. 9) of the web respectively engage the bevels 103 and 104 on the folding fingers 31 and 32. The bevels 103 and 104 simultaneously move the edge portions 20a and 20b upwardly relative to the remaining portion of the web in the manner shown in FIG. 9.

Upon continued movement of the web 20 along the outfeed portion 62 of the folding element 30, the surfaces 96 and 97 on the fingers 31 and 32 simultaneously turn the edge portions 20a and 20b over the rounded folding edges 65 and 66 on the outfeed portion. As the edge portions 20a and 20b reach the position shown in FIG. 10, they are substantially entirely turned over the outfeed portion and are maintained by the fingers 31 and 32 in close juxtaposition with the outfeed portion's upper surface. At the time the web reaches the position illustrated in FIG. 11, the turning over of the edge portions is complete, thus forming a fold of C-shaped cross-section.

The C-folded webs 20 proceed from their corresponding folding elements 30 and are creased by the outfeed rollers 34 (FIG. 1) as they move along the stack 21. The conveyor belt 112 continues to advance the webs along the path of the stack to the discharge end of the machine.

Referring to FIGS. 14 and 15, there is shown an integral one-piece casting 115 which is useful in connection with another preferred embodiment of the invention. The casting 115 includes a generally triangular mounting portion 116 having three apertures 117 therein which are arranged to accommodate the mounting bolts 86 (FIG. 7). Two converging folding fingers 120 and 121 are cast on opposite sides of the mounting portion 116. The folding fingers 120 and 121 are of a configuration generally similar to the folding fingers 31 and 32 described heretofore and include the cut-away portions 98 and 99 which extend in parallel vertical planes adjacent the forward ends of the fingers. The bevels 103 and 104 on the fingers 31 and 32 have
been omitted on the fingers 120 and 121, however, and the fingers 120 and 121 are instead provided with inwardly directed converging folding surfaces 122 and 123, respectively, which lies in upwardly diverging planes such that each surface meets the bottom face of its finger at a comparatively large acute angle.

The casting 115 serves as an alternative construction for the mounting plate 85, the pins 90, the nuts 92 and the folding fingers 31 and 32 on the folding element 30 of FIGS. 1–13. The mounting portion 116 of the casting 115 is affixed to the ledge 80 by the bolts 86 to firmly hold the casting in place. By utilizing a single continuous casting in lieu of the separate folding fingers 31 and 32, the construction further insures that the fingers remain in rigid fixed positions at all times during the tissue folding operation. The fingers on the casing operate in the manner described heretofore to simultaneously turn the longitudinal edge portions 20a and 20b of the web 20 over the folding edges 65 and 66 on the outfeed portion 62 and thereby form a fold of C-shaped cross-section.

The terms and expressions which have been employed are used as terms of description and not of limitation, and there is no intention, in the use of such terms and expressions, of excluding any equivalents of the features shown and described, or portions thereof, it being recognized that various modifications are possible within the scope of the invention claimed.

What is claimed is:

1. In apparatus for forming longitudinal folds in each of a plurality of webs and for advancing the webs in a continuously moving stack, in combination:
   a series of folding elements, one for each of said webs, positioned along the path of said stack in spaced relationship with each other, each of the folding elements including an infed portion having an infed surface and a substantially flat outfeed portion having first and second outfeed surfaces on opposite sides of said outfeed portion, said first outfeed surface forming an oblique angle with the infed surface, said infed surface having an initial portion at least as wide as the web being fed to said folding element, said outfeed portion being substantially narrower than the initial portion of said infed surface and substantially narrower than the web fed to the folding element, and the remaining portion of said infed surface being tapered from the width of said initial portion to the width of said outfeed portion;
   means affixed to the infed portion of each of the folding elements for supporting the same adjacent said stack;
   means for respectively drawing said webs over the infed and first outfeed surfaces of the folding elements and into the stack so that substantially the entire width of the web is supported as it passes the initial portion of the infed surface and, as the web passes the tapered portion of the infed surface, separate longitudinal portions of the web adjacent the edges thereof become unsupported by the infed surface and form surfaces in the interior of the oblique angle defined by the planes of said infed and first outfeed surfaces;
   a pair of folding fingers of substantially rectangular cross-section overlying the outfeed portion of each of the folding elements, said folding fingers having inwardly directed folding surfaces which converge in the direction of movement of said stack in position to engage the separate unsupported longitudinal edge portions of the corresponding web to turn said longitudinal portions over the outfeed portion and onto said second outfeed surface to form a fold of C-shaped cross-section; and
   an integral mounting device affixed to the outfeed portion of each folding element for maintaining both of the folding fingers for the folding element in fixed relationship with each other and with said outfeed portion.

2. In apparatus as defined in claim 1, in which the mounting device and folding fingers for each of said folding elements comprises a one-piece casting.

3. In apparatus as defined in claim 1, the outfeed portion of each of said folding elements having a pair of rounded folding edges connecting said first and second outfeed surfaces parallel to the direction of movement of said stack.

4. In apparatus as defined in claim 3, the mounting device for each folding element comprising a single substantially flat plate member permanently affixed to both of the corresponding folding fingers; and
   bolts means for securing the plate member to said outfeed portion.

5. In apparatus as defined in claim 3, the mounting device for each folding element comprising a single substantially flat plate member affixed to said outfeed portion, said plate defining a plurality of notches around its periphery;
   means disposed in said notches for initially adjustably locating the folding fingers relative to said plate member; and
   means for fixing the location of said folding fingers once they have been adjustably located.

6. In apparatus for forming longitudinal folds in each of a plurality of webs and for advancing the webs in a continuously moving stack, in combination:
   a first group of folding elements, one for each web to be folded, positioned in spaced relationship with the path of the continuously moving stack;
   means for respectively advancing said webs in unfolded condition along the folding elements in said first group, each of said folding elements forming a longitudinal median fold in the corresponding web;
   a second group of folding elements, one for each of said webs, positioned along the path of said stack in spaced relationship with one another, each of the folding elements in said second group including an infed portion having an infed surface and a substantially flat outfeed portion having first and second outfeed surfaces on opposite sides of said outfeed portion, said first outfeed surface forming an oblique angle with the infed surface, said infed surface having an initial portion at least as wide as the web being fed to said folding element, said outfeed portion being substantially narrower than the initial portion of said infed surface and substantially narrower than the web fed to the folding element, and the remaining portion of said infed surface being tapered from the width of said initial portion to the width of said outfeed portion;
means affixed to the infeed portion of each of the folding elements in said second group for supporting the same adjacent said stack; means for respectively drawing said webs over the infeed and first outfeed surfaces of the folding elements in said second group and into the stack so that substantially the entire width of the web is supported as it passes the initial portion of the infeed surface and, as the web passes the tapered portion of the infeed surface, separate longitudinal portions of the web adjacent the edges thereof become unsupported by the infeed surface and form surfaces in the interior of the oblique angle defined by the planes of said infeed and first outfeed surfaces; a pair of folding fingers of substantially rectangular cross-section overlying the outfeed portion of each of the folding elements in said second group, said folding fingers having inwardly directed folding surfaces which converge in the direction of movement of said stack in position to engage the separate unsupported longitudinal edge portions of the corresponding web to turn said longitudinal portions over the outfeed portion and onto said second outfeed surface to form a fold of C-shaped cross-section; and an integral mounting device affixed to the outfeed portion of each folding element in said second group for maintaining both of the folding fingers for the folding element in fixed relationship with each other and with said outfeed portion.