Jan. 11, 1966 W. T. CHODOROWSKI 3,228,710

FOLDING OF PAPER AND LIKE MATERIAL

Filed May 18, 1965 2 Sheets-Sheet 1

FIG. 1

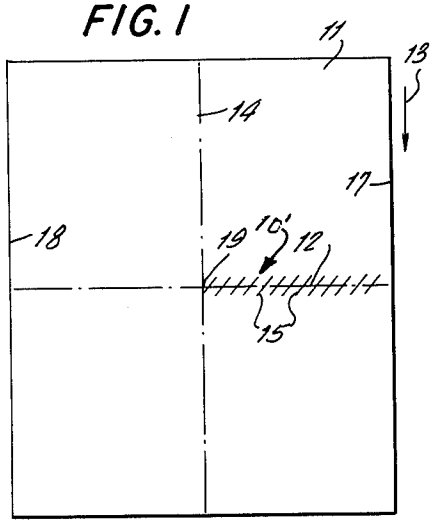
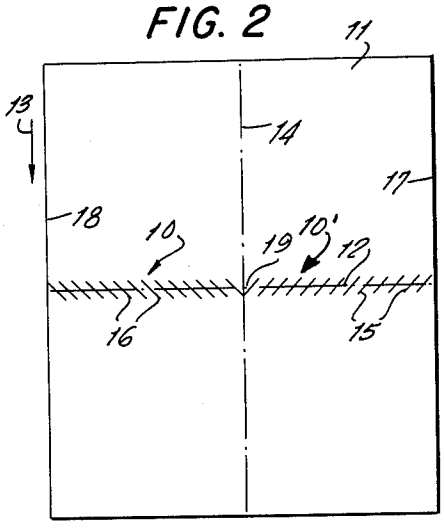


FIG. 2



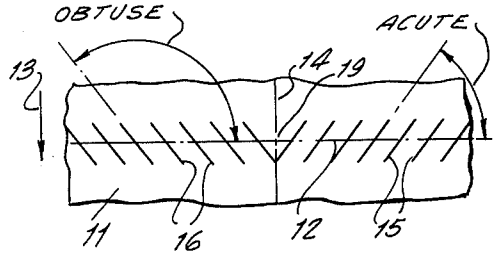


FIG. 2A

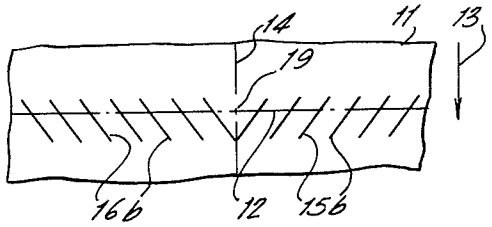


FIG. 2b

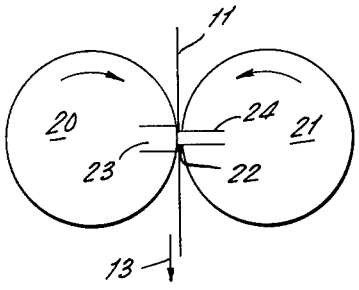


FIG. 3

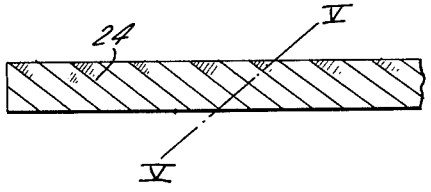


FIG. 4

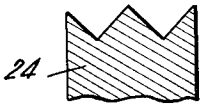


FIG. 5

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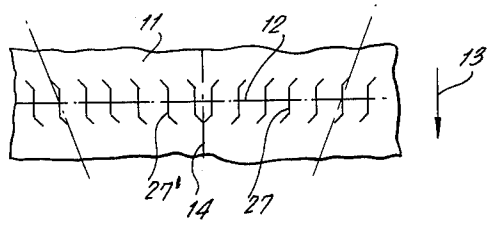
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Jan. 11, 1966 W. T. CHODOROWSKI 3,228,710

FOLDING OF PAPER AND LIKE MATERIAL

Filed May 18, 1965 2 Sheets-Sheet 2

FIG. 6



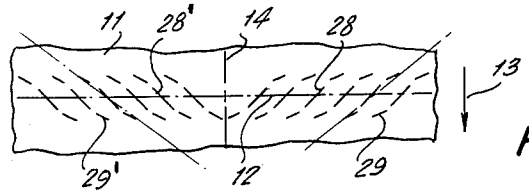
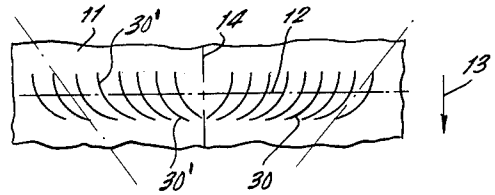


FIG. 7

FIG. 8



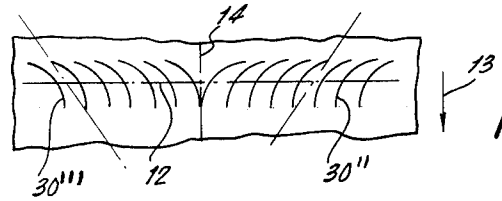


FIG. 9

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3,228,710

FOLDING OF PAPER AND LIKE MATERIAL

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Filed May 18, 1965, Ser. No. 456,797
12 Claims. (Cl. 281—38)

This invention relates to the folding of paper and like material hereinafter referred to, for convenience, as paper and is a continuation-in-part of my copending application Serial Number 333,492, filed December 26, 1963, now abandoned.

A common form of folding action for folding paper, carried out in folding machines, applied to book and allied printing presses, comprises taking a sheet of paper, or superimposing several sheets of paper which may have been cut off from a web to form a section, or taking a multisheet section obtained by previous folding of a sheet, and causing the sheet or section to travel through a folding machine and be cross folded. That is, first sheet or section is folded along a first fold line to form a first or cross fold, and then it is folded along a second fold line. The first fold line is a center line which is at right angles to the direction of travel. When the sheet or section thus folded is again folded, to form a second fold, in a separate fold unit, the second fold line is a center line which is in the direction of travel, that is, at right angles to the first fold.

As a result of this double folding of the sheet, or section, or multisheet section, troublesome gussets or creases form inside the intersection of the two folds. Until the advent of the present invention, there was no known way to twice fold a sheet or section and avoid obtaining these gussets and creases.

It is known in the art to provide perforations in a straight interrupted line along the line of the first or cross folds before folding, in order to reduce the tendency of such gussets or creases to develop. This procedure is suggested for example, in United States Patent Number 2,775,448. However, sheets or sections folded according to this Patent still have creases and gussets inside the intersection of the two folds. This Patent therefore, fails to solve the problem. Moreover, when such perforations are applied to heavy sections, it is necessary to perforate to such an extent, by providing large perforations and/or by close spacing of the perforations, that the paper is weakened and it breaks or tears before the first fold is completed. Such a result is, of course, undesirable for broken or torn sections may jam the folder and any broken or torn sections which pass through the folder will cause stacking difficulties.

The object of the present invention is to provide an improved form of perforation or slit which eliminates the formation of gussets or creases and to maintain the strength of the paper before the first fold is made, as well as after. It is also important to have perforations or slits such that while folding is enhanced, excess trimming is not required. The perforations or slits should be kept short since paper is the most expensive part of any book, and waste must be minimized if the procedure is to be economical.

For convenience of description a sheet, a section comprising a series of superimposed sheets, and a multisheet section comprising a sheet which has previously been folded, will each be referred to hereinafter as a section or a section of paper sheets.

According to my invention, the section of paper sheets is provided with an area of perforations or slits along at least part of the first fold line, for example extending to the intersection of the first fold line with the second fold line. The perforations or slits extend across the first fold line and the upper portion of the perforation or slit forms an acute angle with the first fold line. The perforations or slits may be straight, curved or sinuous, or variations thereof.

The area of perforations or slits may also extend the whole way along the line of the first fold providing the angles are correct. In such cases, the perforations or slits beginning at the right edge of the sheet and moving left toward the intersection of the first and second fold lines should be at an acute angle while the perforations or slits beginning beyond the intersection of the first and second fold lines and continuing toward the left edge of the sheet should be at an obtuse angle. For convenience, and to avoid confusion, the appropriate angle can in all cases, regardless of the configuration of the perforations or slits, be defined as follows. Directing attention first to perforations or slits on the right-hand section of the first fold line, that is, that portion of the first fold line lying between the second fold line and the right edge of the sheet, if the two end points of any perforation or slit in that area were to be joined by a straight line, that portion of such theoretical straight line beginning at the first fold line and extending above the first fold line must form an acute angle with the first fold line. Likewise, when dealing with the left-hand portion of the first fold line, that is, that portion of the first fold line beginning at the intersection of the first and second fold lines and extending toward the left edge of the sheet, the obtuse angle can be similarly defined. If the two end points of a perforation or slit of any configuration lying in that area were joined by a straight line, the portion of the theoretical line beginning at the first fold line and extending above it, must form an obtuse angle with the first fold line.

It can therefore be appreciated that while the preferred perforation or slit configuration is a straight line whose angle is acute or obtuse as defined above, any configuration of a perforation or slit would function as well, so long as its angle meets the above requirements.

It should also be appreciated that the perforations or slits can be provided either on the right-hand section of the first fold line or on both right and left-hand areas of the first fold line.

In the accompanying drawings:

FIGURE 1 is a plan view of a section of paper sheets having perforations or straight slits on the right-hand portion only but before being folded;

FIGURE 2 is a similar view to FIGURE 1 but showing such perforations or slits on the left-hand side of the first fold line as well as the right-hand side;

FIGURE 2A is similar to FIGURE 2 but shows slits extended to more clearly illustrate the correct angles, for example, acute and obtuse;

FIGURE 2B is similar to FIGURE 2 but shows slits which are asymmetrically disposed across the first fold line;

FIGURE 3 is a diagrammatic elevation of one form of apparatus for perforating a section of paper sheets;

FIGURE 4 is an elevation of a knife, looking at the cutting edge, suitable for use in the apparatus shown in FIGURE 3;

FIGURE 5 is a transverse section of the knife, on the line V—V in FIGURE 4;

FIGURE 6 shows slits of reverse Z- and Z-configuration along both the right-hand and left-hand areas of the first fold line;

FIGURE 7 is similar to FIGURE 6 but shows slits having an S- and reverse S-configuration which form a smaller acute angle and a greater obtuse angle than shown in FIGURE 6;

FIGURE 8 is similar to FIGURE 6 but shows curved slits; and

FIGURE 9 is a variant of FIGURE 8.

Referring to FIGURE 1, there is shown a section of paper sheets 11, formed by a series of sheets which have been cut from a web and superimposed on each other. The line of the first or cross fold is indicated at 12, and this line is at right angles to the direction of travel of the sheets during the folding operation. Arrow 13 indicates the direction of travel of the section through that section of the folding machine which effects this first fold. The line of the second fold is indicated at 14, and is perpendicular to the first fold line and is parallel to the direction of travel indicated by the arrow 13; it is usually disposed along the center line of the section. Numeral 19 indicates the intersection of the first and second fold lines.

Numeral 10' indicates an area of perforations or slits 15 along the first fold line beginning at the right-hand edge 17 of section 11 to intersection 19. The perforations or slits are spaced from each other. In FIGURE 1, each perforation or slit is shown as a continuous straight line extending symmetrically across fold line 12. As can be more clearly seen from FIGURE 2A, that portion of a straight line drawn to join the two end points of any configuration of perforation or slit lying in the right-hand portion of said section across said first fold line 12, which line begins at said first fold line and extends above said first fold line, forms an acute angle with said first fold line.

In the modified arrangement shown in FIGURE 2, the areas of perforations or slits 10 and 10' extend along the entire length of first fold line 12. The perforations or slits 16 which extend from intersection 19 to the left-hand edge 18 of the section, are also shown as straight lines. As is also shown by FIGURE 2A, symmetrically disposed perforations or slits 16, are at an obtuse angle with respect to first fold line 12. This obtuse angle is defined similarly to the acute angle of slits 15. If the two end points of a perforation or slit of any configuration lying in the left-hand portion across first fold line 12 were joined by a straight line, that portion of that straight line which begins at said first fold line 12 and extends upward, forms an obtuse angle with said first fold line. When a section of paper sheets is perforated or slit according to either FIGURES 1 or 2 and is folded first about the line 12 and subsequently about the line 14, the tendency to gusset or crease at the intersection 19 of the two fold lines will be wholly or substantially eliminated.

While FIGURES 1, 2 and 2A have shown the perforations or slits 15 and 16 to be disposed symmetrically with respect to first fold line 12, creasing and gusseting at intersection 19 can also be eliminated when these perforations or slits are disposed asymmetrically about fold line 12 as shown in FIGURE 2B. It has furthermore been found to facilitate the step of stacking the twice folded sections to asymmetrically disposed perforations or slits 15*b* and 16*b* about fold line 12 when both the left-hand and right-hand portions of fold line 12 have these perforations or slits. The asymmetrical disposition of these perforations or slits does not affect the requirement that the slits along the right-hand portion of fold line 12 have an acute angle and the slits along the left-hand portion of fold line 12 have an obtuse angle with respect to fold line 12. It is furthermore essential to bear in mind that the exact angle is not critical. What is essential, is that the perforations or slits have acute and obtuse angles with respect to fold line 12 as defined above. It has been found particularly advantageous to have the acute angle range from 20 to 50° and the obtuse angle to range from 160 to 130°. The exact acute or obtuse angle chosen in any particular case may be affected by factors other than optimum folding without creases and gussets. Therefore while applicant has found this range to be more advantageous for his operation, the real criticality lies in the fact that the angles must be acute and obtuse respectively rather than 90°.

When the perforations or slits are angled as suggested above, not only are creases and gussets substantially eliminated, but the paper areas between the perforations or slits are quite strong. This strength is important, for weak or torn sections may jam the folder and any such sheets which pass through the folder will cause stacking difficulties.

A suitable form of apparatus for effecting perforation of the section of paper sheets is shown in FIGURE 3. Therein two cooperating cylinders 20 and 21, rotating in opposite directions to a nip 22, are provided with an anvil 23 in the cylinder 20 and with a cooperating knife 24 in the cylinder 21. At the moment of cooperation with each other to effect perforation of the section 11, the anvil 23 and the knife 24 are travelling at the same speed as the section 11.

The knife 24 may be provided with serrated teeth 25 as shown in FIGURES 4 and 5, which are inclined to the cutting edge of the knife as shown in FIGURE 4.

FIGURES 6 to 9 show alternative configurations for the perforations or slits 15 and 16. In every case the two end points of each perforation or slit could be joined by a theoretical straight line which would form an acute or obtuse angle with first fold line 12, as defined above.

FIGURE 6 shows slits 27 and 27' as having a substantially reverse Z- and Z- configuration respectively. The two end points of one slit 27 are shown to be joined by a theoretical straight line which forms the requisite acute angle with fold line 12. Likewise, one slit 27' is shown having a theoretical straight line joining its end points, which forms the requisite obtuse angle with fold line 12. FIGURE 7 shows a broken S- configuration and a broken reverse S- configuration. The two configurations comprise an inclined line 28 or 28' with inclined perforations 29 and 29' at each end. Again a theoretical straight line is shown joining the two end points of the S- and reverse S- configurations which forms the requisite acute and obtuse angles with fold line 12.

FIGURE 8 shows curved slits 30 and 30'. A theoretical straight line joining the two end points is shown, which forms the requisite acute and obtuse angles.

FIGURE 9 shows curved slits 30'' and 30''' which are variants of 30 and 30'. The acute and obtuse angles are likewise illustrated.

It should be appreciated that while FIGURES 6 to 9 have shown, for convenience, perforations or slits extending both from the right-hand edge 17 toward the intersection of fold lines 12 and 14, and from the intersection to the left-hand edge 18, it is still equally advantageous regardless of the configurations of the perforations or slits that they be only on the right-hand portion of the fold line 12. It is also possible to have the perforations or slits only on the left-hand portion of fold line 12 depending upon the direction of the force applied when the section is folded for the second time.

When the right-hand portion of fold line 12 is perforated or slit, or, when both the left-hand and right-hand portions of fold line 12 are perforated or slit, section 11 is folded such that the upper portion of section 11 is on the outside after the section is folded.

It has been found that perforations or slits according to the present invention allow the section to move laterally during the folding operation. The sheets move laterally because the paper between the perforations or slits is substantially in compression as a strut; it is weak in this form of loading and buckles easily. Up to 64 page sections have been produced without creases or gussets at the fold, which all prior techniques prevented such movement and therefore caused undesirable creases and gussets. Even the heaviest of paper can satisfactorily be used and applicant has obtained excellent results with 50

pound paper. This ability for movement of the inner portion of the section relative to the outer portion of the section is the underlying principle of the present invention. The acute and obtuse angles of the perforations or slits are an integral part of this principle.

It is therefore believed that other and further uses and variations on the foregoing configurations will be appreciated by those skilled in the art by reference to the foregoing specification and the appended claims.

What is claimed is:

1. A section of paper sheets having a first fold line extending from the right-hand edge of the section to the left-hand edge of said section, a second fold line intersecting the first fold line and substantially perpendicular thereto and slits extending across the first fold line from the right-hand edge to the intersection of the first and second fold lines, said slits being angled with respect to the first fold line such that if the two end points of any slit were joined by a straight line, that portion of said line beginning at said first fold line and extending upward therefrom, would form an acute angle with the first fold line.

2. A section of paper sheets having a first fold line extending from the right-hand edge of the section to the left-hand edge of said section, a second fold line intersecting the first fold line and substantially perpendicular thereto, a first series of slits extending across the first fold line from the right hand edge to the intersection of the first and second fold lines, said first series of slits being angled with respect to the first fold line such that if the two end points of any slit were joined by a straight line, that portion of said line beginning at said first fold line and extending upwardly therefrom, would form an acute angle with the first fold line, and a second series of slits extending across the first fold line from the left-hand edge to the intersection of the first and second fold lines, said second series of slits being angled with respect to the first fold line such that if the two end points of any slit were joined by a straight line, that portion of said line beginning at said first fold line and extending upward therefrom, would form an obtuse angle with the first fold line.

3. A section of paper sheets according to claim 1 wherein said slits are straight lines.

4. A section of paper sheets according to claim 1 wherein said slits comprise a series of perforations.

5. A section of paper sheets according to claim 1 wherein said slits have a broken S-configuration.

6. A section of paper sheets according to claim 1 wherein said slits have a reverse Z-configuration.

7. A section of paper sheets according to claim 1 wherein said slits are curved lines.

8. A section of paper sheets according to claim 2 wherein said first and second series of slits are straight lines.

9. A section of paper sheets according to claim 2 wherein said first and second series of slits comprise a series of perforations.

10. A section of paper sheets according to claim 2 wherein said first and second series of slits are curved lines.

11. A section of paper sheets according to claim 2 wherein said first series of slits has a broken S-configuration and said second series of slits have a broken reverse S-configuration.

12. A section of paper sheets according to claim 2 wherein said first series of slits has a reverse Z-configuration and said second series of slits has a Z-configuration.

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GEORGE O. RALSTON, *Primary Examiner.*