Feb. 23, 1965 F. M. BIGGAR, JR 3,170,685

SHEET MATERIAL FOLDING METHOD AND APPARATUS

Filed June 10, 1963 4 Sheets-Sheet 1

Fig. 1.

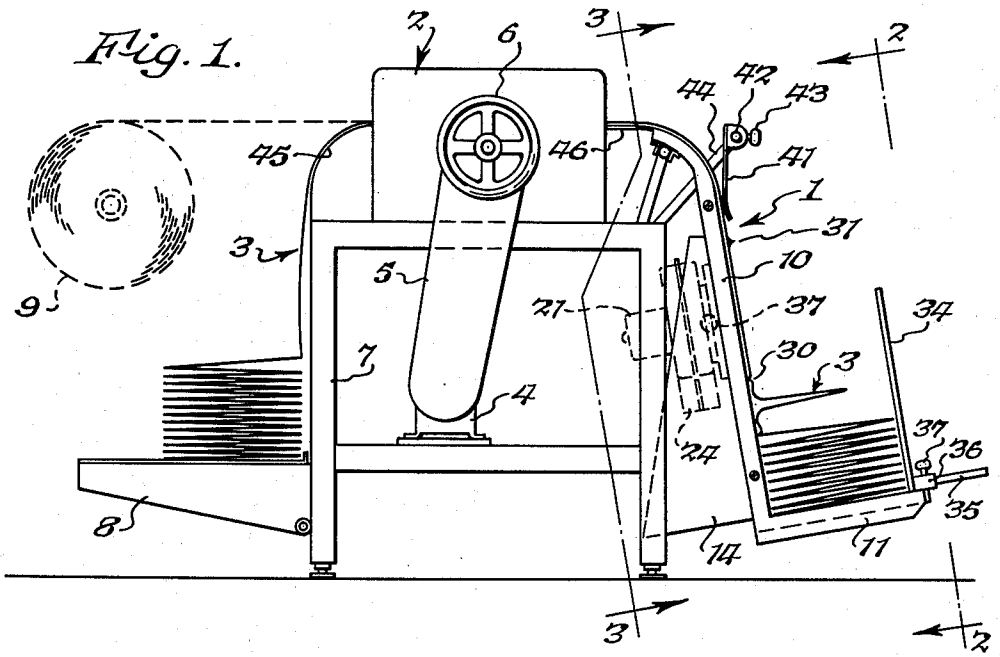
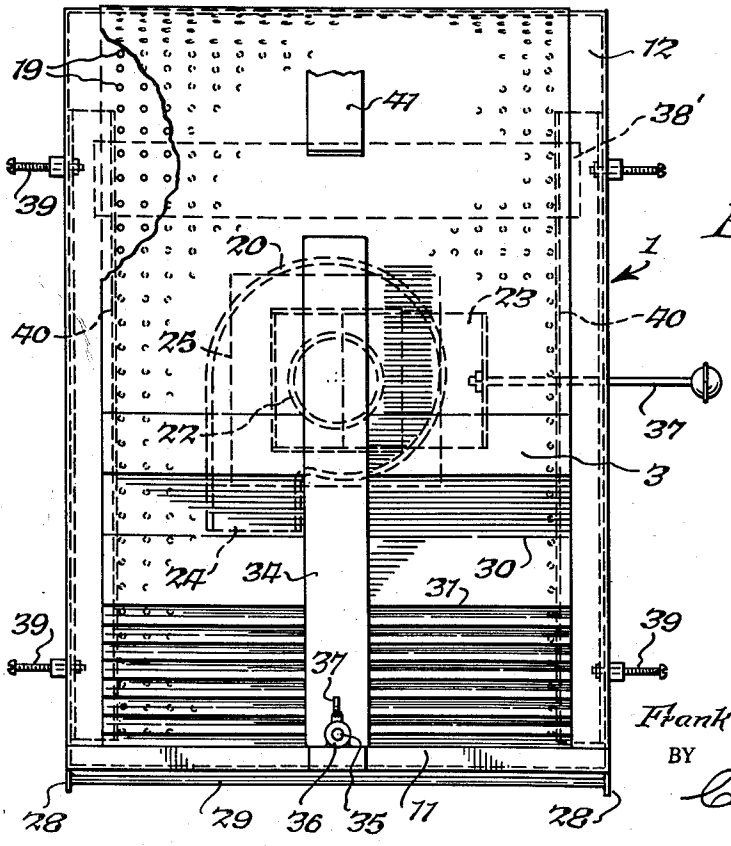



Fig. 2.



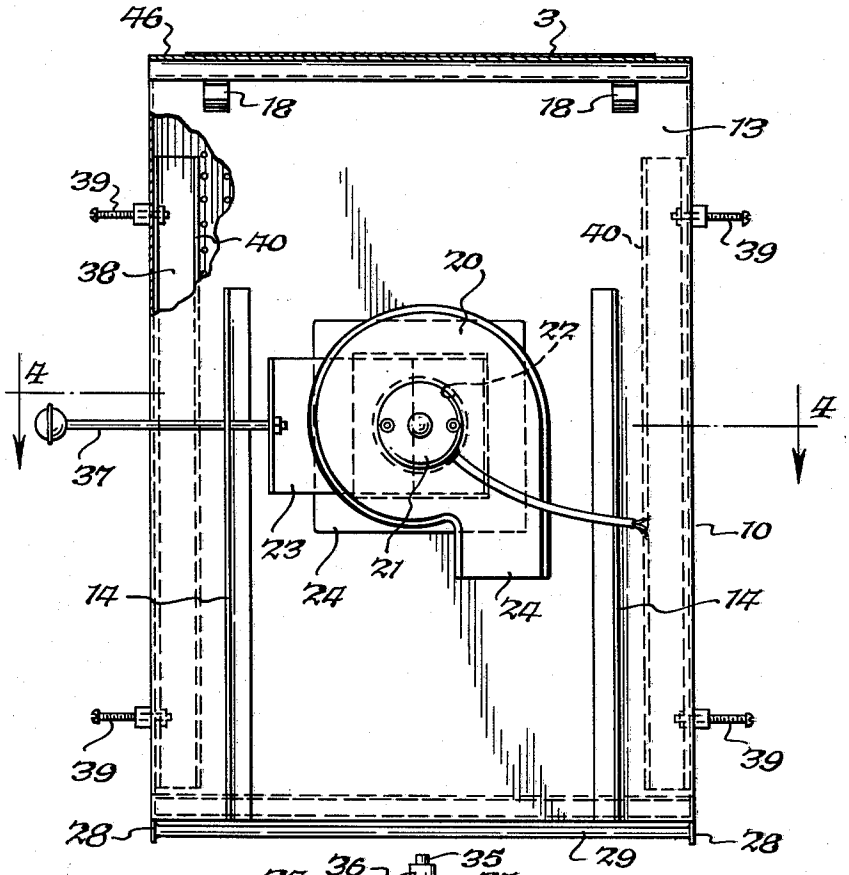

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SHEET MATERIAL FOLDING METHOD AND APPARATUS

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Fig. 3.



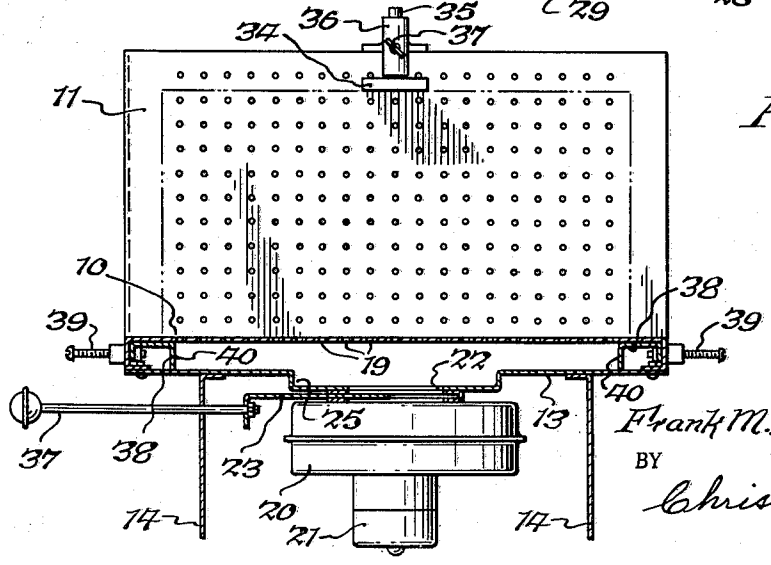




Fig. 4.

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SHEET MATERIAL FOLDING METHOD AND APPARATUS

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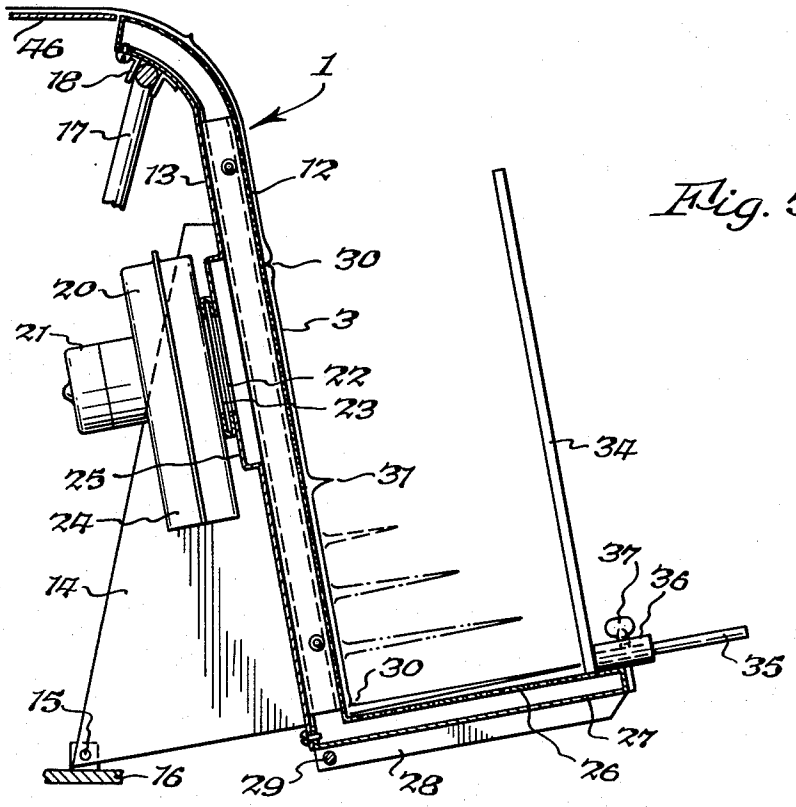



Fig. 5.

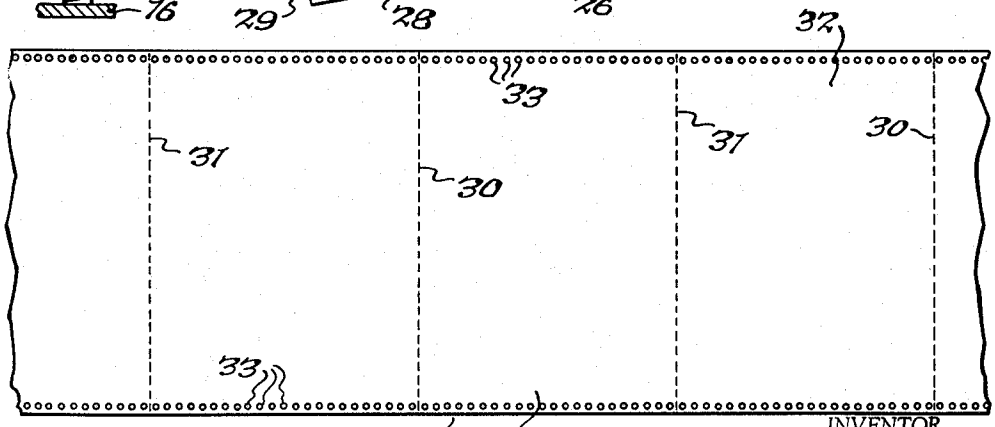



Fig. 6.

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SHEET MATERIAL FOLDING METHOD AND APPARATUS

Filed June 10, 1963 4 Sheets-Sheet 4

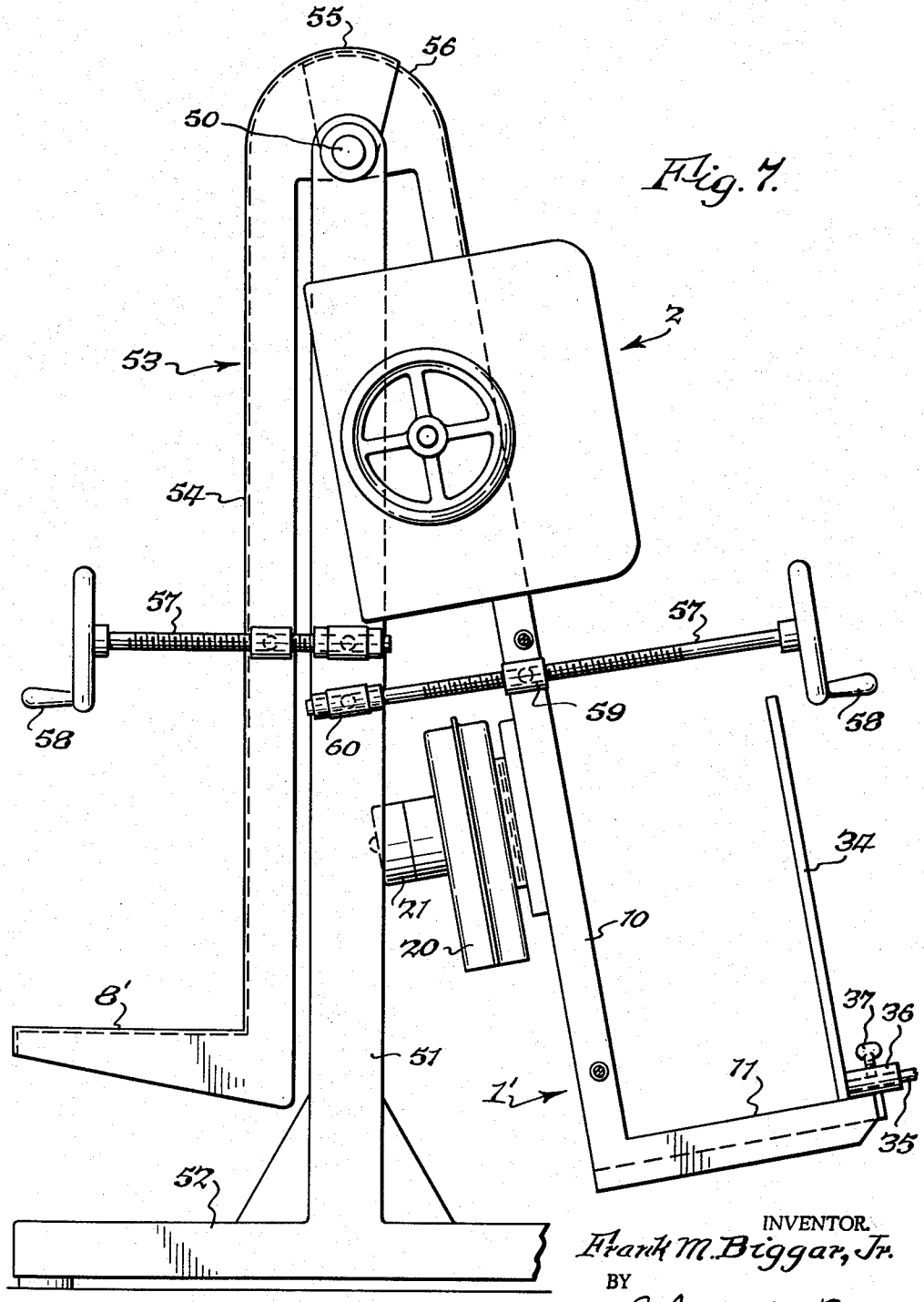



Fig. 7.

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United States Patent Office 3,170,685
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3,170,685

# SHEET MATERIAL FOLDING METHOD AND APPARATUS

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10 Claims. (Cl. 270—68)

This invention relates generally to the art of folding sheet material such as paper, and more specifically to a new and useful method of and apparatus for folding continuous web sheet material having successive lines of folding therealong.

While the method and apparatus of my invention have been developed for the folding of paper, they can be adapted to the folding of other sheet materials. Therefore, while I refer primarily to paper, and the printing industry, that is done by way of illustration and is not intended to limit the uses to which my invention can be put.

Printing, crimping, perforating, collating and other operations can be performed at high speed. However, heretofore it has not been possible to fold the paper as fast as it can be delivered from the processing machine. As a result, the relatively slow speed of folding has been a severely limiting factor.

Such folding mechanisms as have been available operate at relatively low speeds compared to the speeds with which printing and other operations can be performed. Furthermore, they tend to be relatively expensive, and limited as to the types, sizes and thicknesses of paper which they can handle.

Accordingly, a primary object of my invention is to provide a method of and apparatus for folding continuous webs of material, including paper, carbon coated paper and other sheet material, at speeds substantially higher than heretofore obtainable.

Another object of my invention is to provide a folding apparatus which is substantially universal, being usable in conjunction with virtually any sheet material processing machine.

It is also an object of my invention to provide a folding apparatus which can handle paper and other sheet material of any width, fold length, and bulk with only a few, simple adjustments.

Still another object of my invention is to provide a folding apparatus which does not require synchronizing or timing with the paper feeding or delivery mechanism.

In addition, it is an object of my invention to provide a folding apparatus which is simple and compact in construction, comprising a relatively few, inexpensive parts.

In one aspect thereof, an apparatus for folding sheet material constructed in accordance with my invention is characterized by the provision of a supporting back and a ledge, means for feeding sheet material along the back to the ledge, and means holding the sheet material against the back while permitting the material to fold as it moves against the ledge.

In another aspect thereof, an apparatus for folding sheet material constructed in accordance with my invention is characterized by the provision of folding guide means having a normally generally upright supporting back and a ledge, supply guide means having a normally generally upright back, means supporting the folding and supply guide means in generally back to back relation, and means for feeding sheet material upwardly along the supply guide back and thence downwardly along the folding guide back to the folding guide ledge.



In one aspect thereof, the method of folding sheet material in accordance with my invention is characterized by the steps of feeding the material along a supporting backing, resisting forward motion of the material at a leading edge thereof, and holding the material to the backing while enabling folding thereof.

In another aspect thereof, the method of folding sheet material in accordance with my invention is characterized by the steps of feeding the material generally downwardly through a folding zone, holding the material against a supporting backing as it passes through the folding zone, and performing work on the material as it passes to the folding zone and while the material is in substantially the plane of the folding zone.

The foregoing and other objects, advantages and characterizing features of the folding method and apparatus of my invention will become clearly apparent from the ensuing detailed description of certain illustrative embodiments thereof, considered in conjunction with the accompanying drawings showing the same, wherein like reference numerals denote like parts throughout the various views and wherein:

FIG. 1 is a side elevational view of a paper crimping machine having a folding apparatus of my invention on the outfeed side thereof and showing, in broken lines, an alternate infeed arrangement;

FIG. 2 is an end elevational view of the folding apparatus, on an enlarged scale, taken about on line 2—2 of FIG. 1, parts being broken away for ease of illustration and to show details;

FIG. 3 is an opposite end elevational view thereof, taken about on line 3—3 of FIG. 1;

FIG. 4 is a transverse sectional view thereof, taken about on line 4—4 of FIG. 3;

FIG. 5 is a vertical sectional view thereof;

FIG. 6 is a fragmentary, plan view of the paper, prior to folding; and

FIG. 7 is a side elevational view of a modified apparatus of my invention.

Referring now in detail to the accompanying drawings, there is shown in FIGS. 1–5 a folding apparatus of my invention, generally designated 1, positioned on the outfeed side of a crimping mechanism, generally designated 2. Mechanism 2 comprises no part, per se, of my invention, and can be any conventional mechanism for performing any operation on the web of paper 3 as it passes therethrough. For example, it can be a crimping machine, a perforating machine, a printing machine or a collating machine.

Machine 2 includes means for feeding the web of material 3 through machine 2 and to the folding apparatus 1, such means comprising for example an electric motor, indicated at 4, connected through a gear or drive belt arrangement contained in housing 5 to a suitable drive, not shown, in the machine. A hand wheel 6 is provided for controlling the operation of machine 2, which is mounted on a supporting framework 7. A bracket 8, comprising a base on which web 3 can be stacked in folded condition prior to crimping and refolding, is mounted on framework 7 on the infeed side of machine 2. Alternately, web 3 can be otherwise supplied, as from a roll, indicated at 9.

Folding apparatus 1 comprises a supporting back 10 and a stacking base 11. Back 10 comprises a front wall 12 spaced from a back wall 13, which latter is mounted

on brackets 14 pivoted at 15 on a part 16 of machine frame 7. Part 16 is mounted for generally horizontal movement, indicated by the arrows in FIG. 5, to selectively vary the inclination of back 10. Supporting struts 17 project from the top of frame 7 into engagement with brackets 18 on the rearwardly curving upper extension of back wall 13, whereby the entire folding apparatus is removably, pivotally supported on the machine frame 7. Front wall 12 also has a rearwardly curving upper extension which is joined to back wall 13 at its extended upper end.

The front wall 12 of supporting back 10 is perforated, as shown at 19, to provide a screen-like construction. A blower 20, driven by a motor 21, has an inlet 22 which can be throttled by a slide valve 23, and an outlet 24. Blower 20 is mounted on a rearwardly projecting extension 25 of back wall 13, with its inlet 22 opening into the space between walls 12 and 13.

In the illustrated construction, stacking base 11 also is provided with spaced walls, the outer wall 26 comprising a continuation of wall 12 and being formed to provide the bottom wall 27 which is joined to back wall 13 at its lower end. Other constructions can be used, however. Reinforcing flanges 28 project downwardly from base 11 on opposite sides thereof, being joined by a crossbar 29.

The web of paper 3 is provided with successive fold lines 30, 31 thereacross, dividing the web into panels 32. These fold lines can be provided in any desired manner, as by scoring or cross perforation, whereby there is defined a series of transverse zones or lines of folding, the term lines being used in a broad sense. The fold lines 30, 31 are formed so that the panels on opposite sides of fold lines 30 fold together in a direction opposite to the direction of folding of the panels on opposite sides of fold lines 31.

Web 3 can comprise a single layer, or multiple layers of continuous material, and can comprise multiple layers of different materials such as interleaved carbon and line hole punched or chart paper. The sheet material 3 also is provided with perforations 33 along the opposite sides thereof, to receive driving teeth or dogs whereby the web is fed through machine 2 and downwardly into the folding apparatus.

In operation, the sheet material 3 is driven through crimping machine 2, being unfolded from supply base 8, and downwardly along the support back 10 of the folding apparatus onto base 11. The first one or two panels are folded onto base 11, to start the operation, and to present an outwardly opening fold 30 as the lower, leading edge of the sheet. I denote the outwardly opening folds 30 infolds, as distinguished from the inwardly opening outfolds 31.

As the leading infold 30 strikes the stacking base 11, its forward motion is arrested. This causes the succeeding pair of panels 32 to begin folding outward about line 31. As shown in FIG. 5, the folding action is progressive as the sheet continues to move downwardly, along back 10, the folding action beginning at line 31 and progressing toward the adjacent lines 30 until the panels 32 are completely folded. This brings the succeeding infold 30 into engagement with base 11, which again acts as a stop, causing a repetition of the aforesaid folding action. A stacking guide is provided in the form of an upright 34, slidable along base 11 toward back 10, having a member 35 slidable in a sleeve 36 and releasably clamped in position by set screw 37. Accordingly, guide 34 can be moved in and out, to accommodate panels of different lengths. Where a stacking base is not desired, it can be replaced by another form of ledge to act as a stop.

The aforesaid folding action requires no synchronizing or timing with the material feed, becausce it is accomplished automatically in response to stopipng the forward movement of the material at an inside fold 30. However, this action requires that the material sheet or web be kept under control at all times as it moves along back 10. This presents a problem, because the sheet material tends to simply bow outwardly, away from the supporting back 10, and become completely uncontrolled. Once control is lost, proper folding will not result.

Accordingly, it is a particular feature of my invention that I maintain the material under control at all times during the folding operation. I accomplish this by constraining the material to follow the supporting back as it is moved downwardly therealong, and to this end I provide means holding the material 3 to the back 10 with sufficient force to maintain it under control while at the same time permitting the aforesaid folding action to occur.

In the illustrated embodiment, this holding action is accomplished by evacuating the space behind the material passing over back 10, through the suction effect produced by blower 20. This results in a pressure differential, on opposite sides of the web 3, holding it against the supporting back 10. However, once the folding starts, along line 31, the pressure differential is broken, permitting the folding to progress while holding the rest of the sheet against the back 10.

Other means holding the material against back 10 can be used. For example, a stream of air can be directed against the front of the material as it moves along back 10. Alternately, means can be provided to produce a controlled electrostatic or magnetic induction force attracting the web 3 to back 10. However, I prefer to use suction, which not only holds the material to the back, but also evacuates between panels 32 as they fold and thereby assists the folding action.

As the speed of travel of the material 3 varies, it is necessary to vary the vacuum force thereagainst. Similarly, as the bulk of the material is varied, it is necessary to vary the vacuum. I conveniently accomplish this by the throttling valve 23, which can be manipulated by the handle 37 projecting through one of the braces 14 to vary the size of the inlet opening 22.

The suction area can be adjusted to conform to the width of the paper. In the illustrated embodiment, this is accomplished by the shutters 38 which are movable across back 10, between walls 12 and 13, upon rotation of the thrust screws 39. Shutters 38 slide across the back of wall 12, and have flanges 40 extending between walls 12 and 13, whereby the perforations can be sealed off, from the outside edges inwardly, to reduce the width of the exposed perforated area. A similar shutter arrangement, indicated at 38', can be provided, extending across the apparatus and movable upwardly and downwardly either behind or in front of back 10 to vary the location of the suction effect.

Perforated wall 12 can be masked at other points, to vary the suction pattern and effect.

Also, as the material 3 moves onto back 10, and before it is subject to the full suction effect, it is necessary at times to restrain the material against moving outwardly under its momentum. This can be accomplished by a restraining member 41, which does not bear downwardly against the paper but is spaced from back 10 a distance sufficient to permit passage of the paper, while confining it to the back 10. Member 41 can be rotated on rod 42, to vary the clearance provided for passage of the paper, and is releasably locked in position by a set screw 43. Rod 42 is carried on supporting braces 44 extending from frame 7.

Curved guides 45 and 46 guide material 3 into and out of machine 2.

Referring now to the embodiment shown in FIG. 7, there is provided a crimping or other machine 2 indentical with the machine 2 shown in FIGS. 1–5 except for its position relative to the folding apparatus 1'. In FIGS. 1–5, paper 3 must negotiate a turn onto supporting back 10 after leaving machine 2. In FIG. 7, however, machine

2 operates on the paper 3 in alinement with the folding apparatus 1'. In other words, the paper 3 moves through machine 2 in the same plane through which it moves as it passes along the supporting back 10 to stacking base 11. To this end, back 10 is extended above the perforated, suction area, to accommodate machine 2 which is secured thereon in any desired manner. The folding action is the same as described above.

Folding apparatus 1' is pivoted at 50 on the center upright 51 of an inverted T-shape supporting frame 42. A supply guide 53 of the same general configuration, but without the suction apparatus, also is pivoted on the frame at 50. Supply guide 53 has a stacking base 8', and a back 54 with a curved upper end 55 telescoping with the curved upper end 56 of apparatus 1'. A suction apparatus can be provided on the supply guide, if desired.

The supply guide 53 and folding apparatus 1' are arranged back-to-back, in generally an A-shaped configuration. This provides an especially compact unit, incorporating machine 2 and avoiding any necessity for the paper 3 to negotiate a turn between machine 2 and folding apparatus 1'.

Further, I provide means for adjusting the angle of inclination of back 10 (and machine 2), to vary the effect of gravity on the paper and thereby accommodate variations in the size and bulk of paper 3. To this end, I provide a rotatable screw shaft 57 having an operating handle 58 at one end and threaded in sleeve 59 pivoted on guide 1'. Shaft 57 is journaled at its other end in a bushing 60 on the frame 52. Accordingly, rotation of shaft 57 varies the angle of inclination of the machine 2 and folding apparatus 1'.

The same can be done with the supply guide 53, through a corresponding screw 57 and actuating handle 58, providing a further adjustment for better control.

Accordingly, it is seen that my invention fully accomplishes its intended objects. I provide an extremely simple folding action, using the paper itself and ambient air pressure, without need of timing or synchronizing, which can be operated at very high speeds. For example, I have refolded 4-part forms with such an apparatus at a rate of 700 feet per minute. While I have described in detail only two embodiments of my invention, that has been done by way of illustration only, it being my intention that the scope of my invention be defined by the appended claims.

Having fully disclosed and completely described my invention, together with its mode of operation, what I claim as new is:

1. Apparatus for folding sheet material having successive fold lines therealong comprising, a normally generally upright rigid stationary supporting back and a stop at the lower end of said back, means for feeding sheet material downwardly along said back and against said stop, and means coacting with said back for producing pressure on the sheet material holding the material against said back, which pressure is less than the buckling force produced in adjacent panels of the material occasioned by the difference in force along the length of the sheet resulting from resistance to movement of the leading end of the sheet by said stop, thereby enabling pairs of successive panels of the material to move away from said back and hold upon themselves as the material moves downwardly along said back against said stop.

2. Apparatus for folding sheet material having successive lines of folding therealong comprising, folding guide means including a generally vertical rigid stationary perforate supporting back portion and a stop portion adjacent the lower end of said back portion, means for feeding sheet material along said back portion against said stop portion, and suction means producing pressure against sheet material passing over said perforate back portion holding such material against said back portion, which pressure is less than the buckling force produced in adjacent panels of the material occasioned by the difference in force along the length of the sheet resulting from resistance to movement of the leading end of the sheet by said stop portion, thereby enabling outfolding of pairs of successive panels of such material in response to engagement of the leading end thereof against said stop portion.



3. Apparatus for folding sheet material having transverse fold lines spaced therealong comprising, folding guide means having a generally vertical rigid stationary supporting back and a stop adjacent the lower end of said back, means for feeding sheet material along said back and against said stop and for continuing to feed the material along said back while forward motion of the material at the leading fold line thereof is resisted by said stop, and means producing a pressure differential on opposite sides of such material for holding the same against said supporting back, which pressure differential is less than the buckling force produced in adjacent panels of the material occasioned by the difference in force along the length of the sheet resulting from resistance to movement of the leading end of the sheet by said stop, thereby enabling outfolding of pairs of successive panels of such material as they move along said back with the leading edge thereof engaged against said stop.

4. Apparatus for folding continuous sheet material having successive fold lines therealong comprising, folding means having a normally generally upright rigid stationary supporting back and a stop adjacent the lower end of said back, supply means having a normally generally upright back, means supporting said supply and folding means in generally back-to-back relation, means for feeding a web of material upwardly along said supply guide back and thence downwardly along said folding means back against said stop and for so feeding the material with the leading fold line thereof held back by said stop, and means coacting with said folding means back for producing pressure on the sheet material holding the web of material against said folding means back, which pressure is less than the buckling force produced in adjacent panels of the material occasioned by the difference in force along the length of the web resulting from resistance to movement of the leading end of the sheet by said stop, thereby enabling the web to fold as it moves along said folding means back against said stop.

5. Apparatus as in claim 4, together with means for selectively adjusting the angle of inclination of said folding means supporting back.

6. Apparatus as in claim 4, together with means for selectively adjusting the angle of inclination of said supply guide back.

7. Apparatus as in claim 4, together with operating means performing an operation on the sheet material passing to said folding means, the path of sheet material through said operating means being substantially alined with the plane of said folding means supporting back.

8. Apparatus as in claim 4, wherein said stop comprises a stacking base.

9. The method of folding sheet material having successive lines of folding alternating in the direction of folding thereof which comprises feeding the material generally downwardly along a rigid stationary support and against a stop, continuing to feed the material along the support with the leading line of folding held by the stop, and holding the material against the support with a pressure less than the buckling force produced in adjacent panels of the material occasioned by the difference in force along the length of the sheet resulting from resistance to movement of the leading line of folding by the stop, thereby enabling folding of the material along successive lines of folding.

10. The method of folding sheet material along successive fold lines which comprises feeding the material generally downwardly through a folding zone along a rigid stationary support while the material is in substantially the plane of the folding zone, resisting forward

motion of the material at the lower end of the folding zone while continuing to feed through the folding zone, and holding the material against the support as it passes through the folding zone with a pressure less than the buckling force produced in adjacent panels of the material occasioned by the difference in force along the length of the sheet resulting from the resistance to forward motion of the material at the lower end of the folding zone, thereby enabling folding of the material along successive fold lines.



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