United States Patent [19]

McCain et al.

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[54] **FOLDING MACHINES**

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[52] **U.S. Cl.** **270/80**

[51] **Int. Cl.** **B65h 45/04**

[58] **Field of Search** 270/67, 80–85; 271/45

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[57] **ABSTRACT**

A machine folds a sheet by inserting a sheet in the bight between a pair of folder rollers, which may be varied in their separation to accomodate sheets having different folding characteristics.

The sheet to be folded is first located in a preinserting position, lying in a plane which spans the gap between the folder rollers, and insertion is made by an inserter blade which strikes the sheet at its medial area and drives it into the roller bight. To condition the sheet for an accurate fold, a shuttle supports the sheet spanning the aforesaid gap until the time just prior to the inserter blade striking the sheet. The sheet may be tensioned or pulled taut in its pre-inserting position.

1 Claim, 13 Drawing Figures

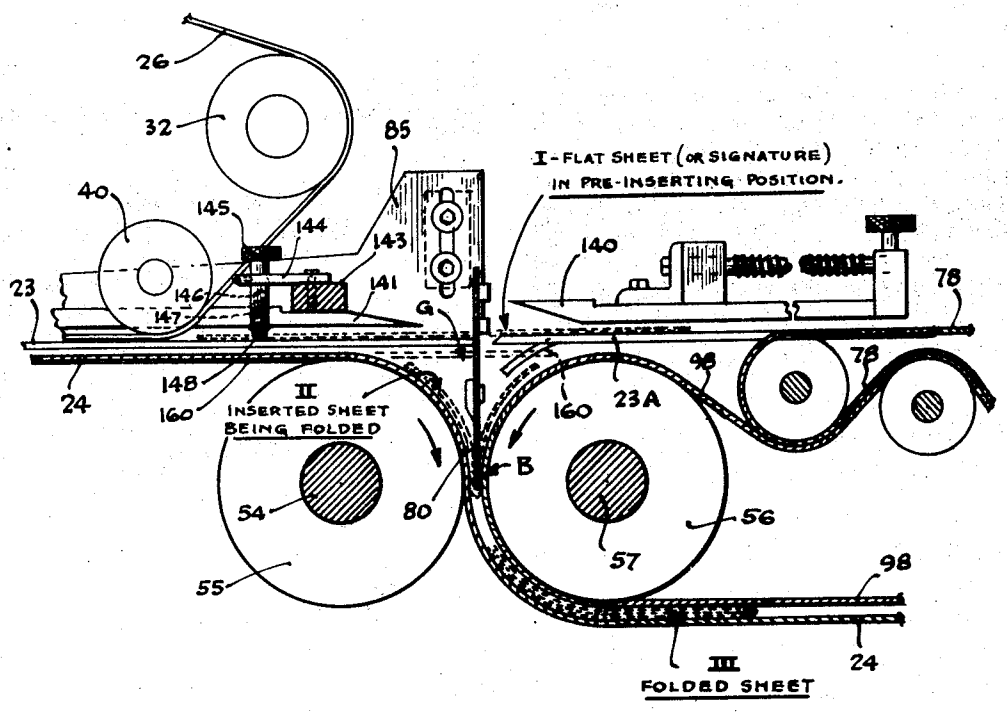


Fig.1

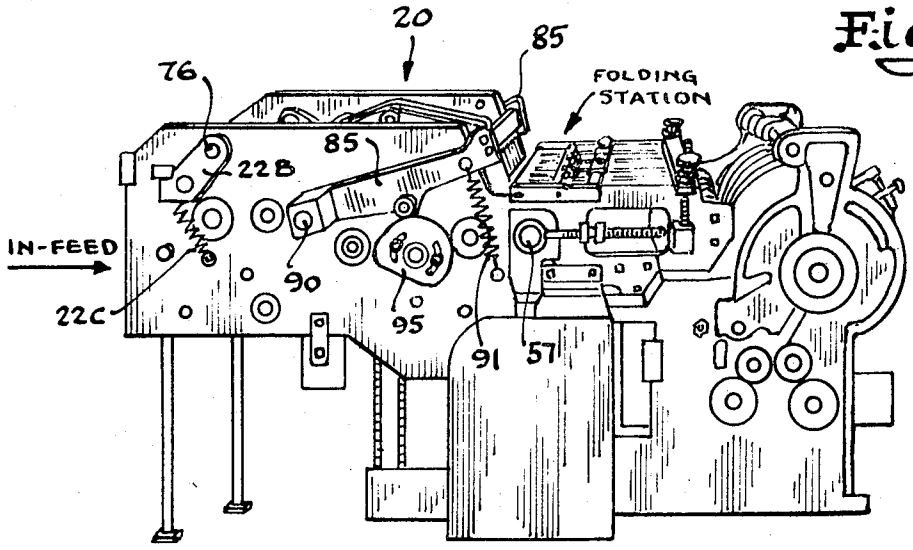
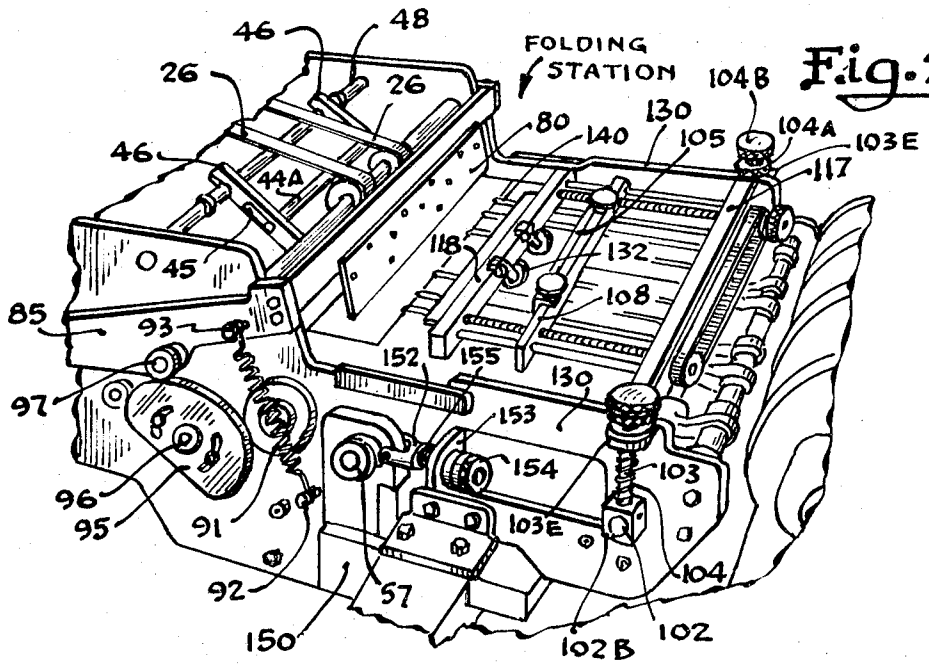
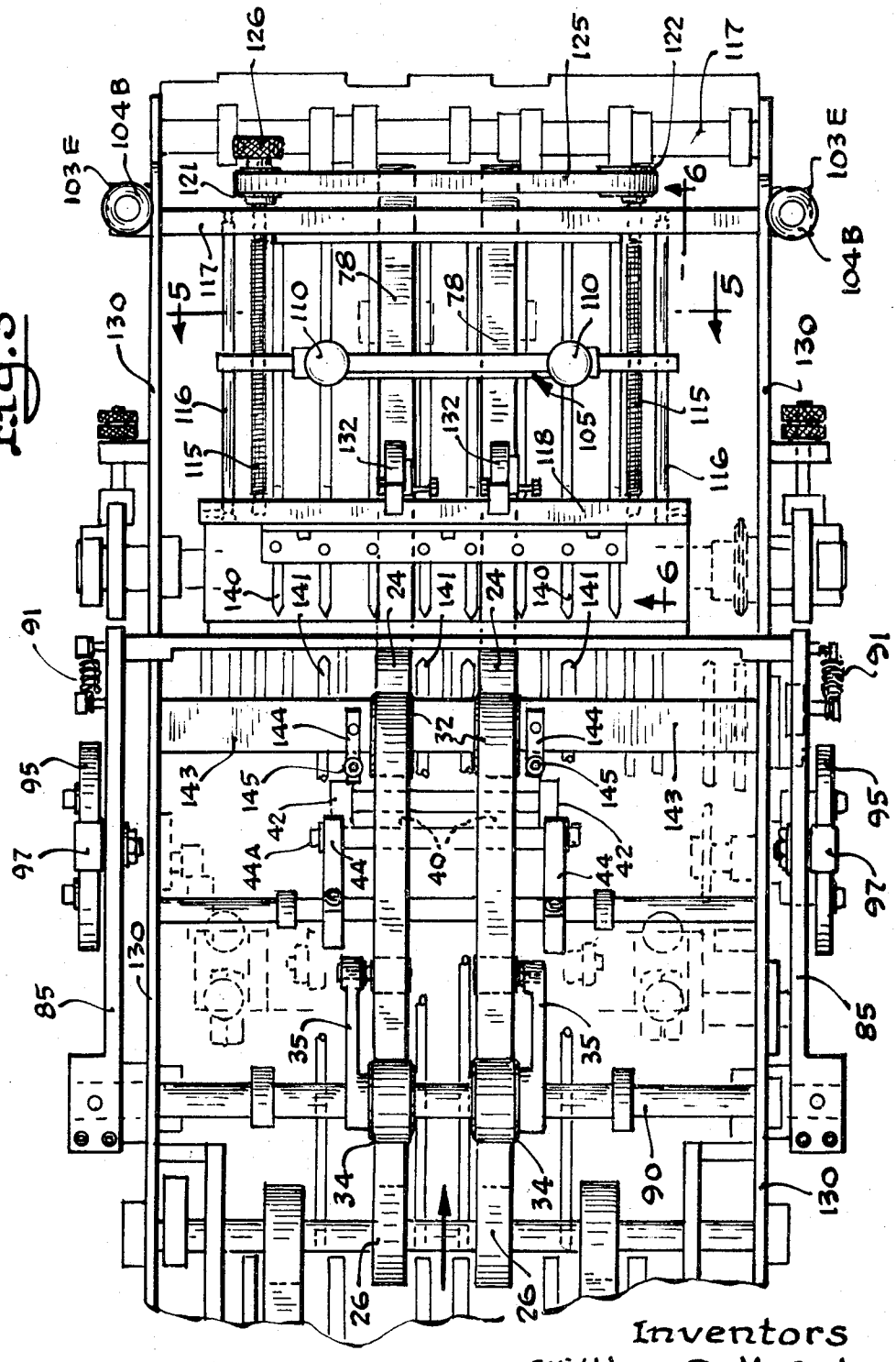


Fig.2



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Fig. 3



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Fig.4

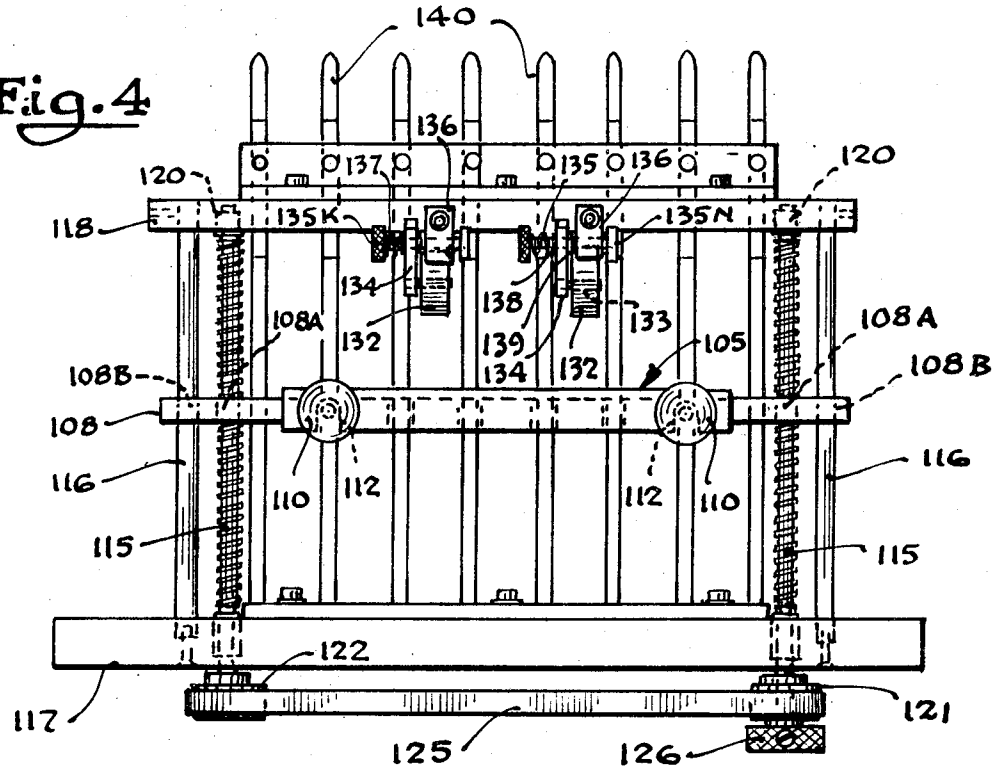


Fig.5

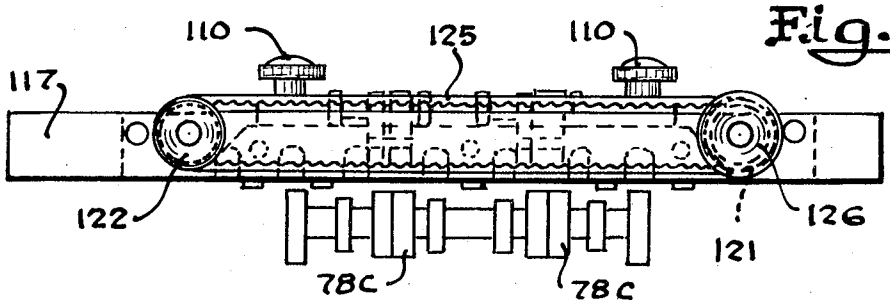
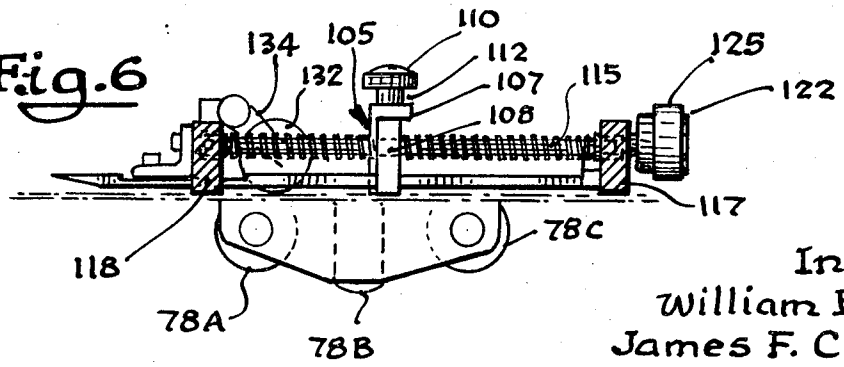


Fig.6



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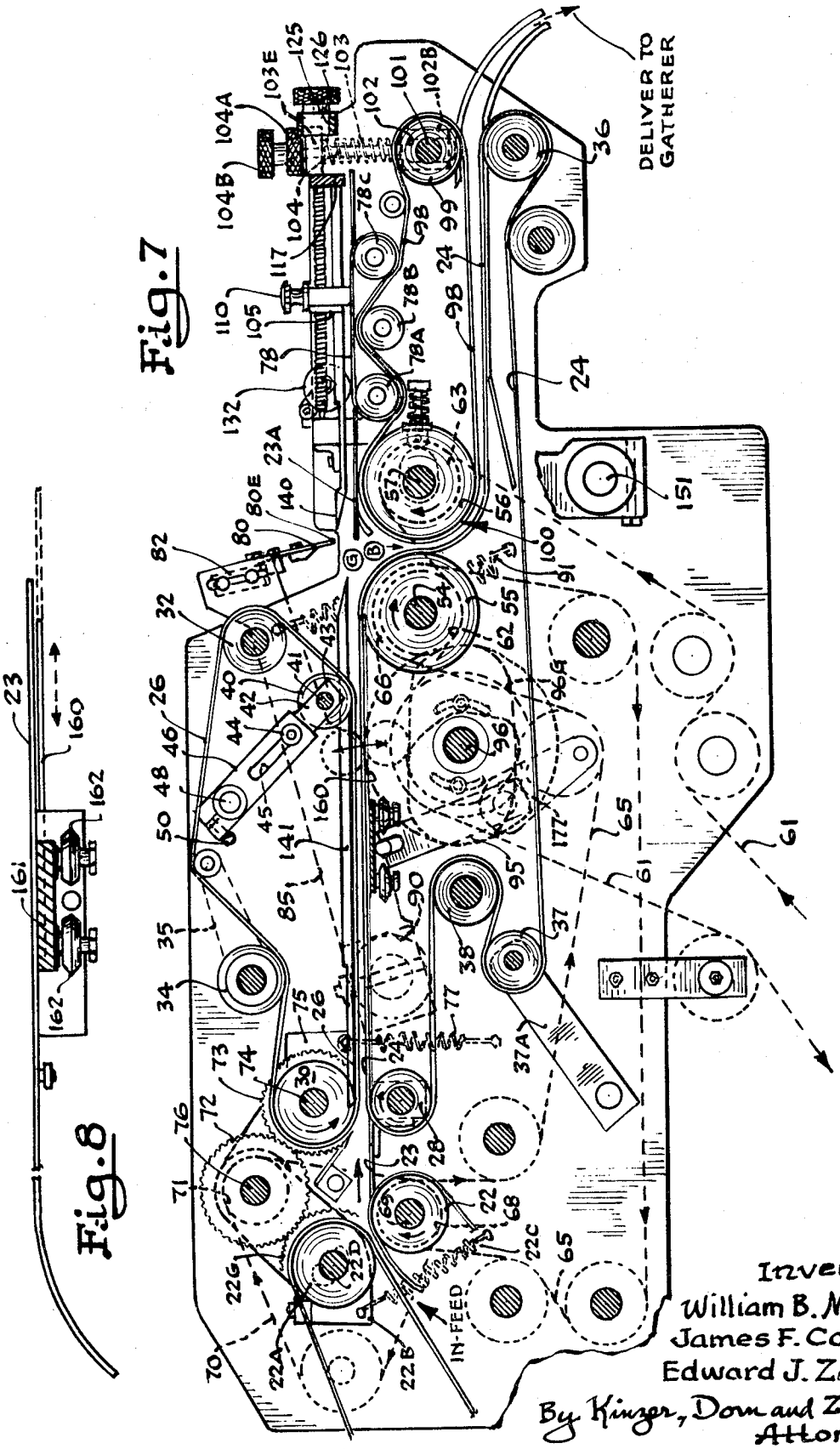


Fig. 7

Fig. 8

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Fig.9

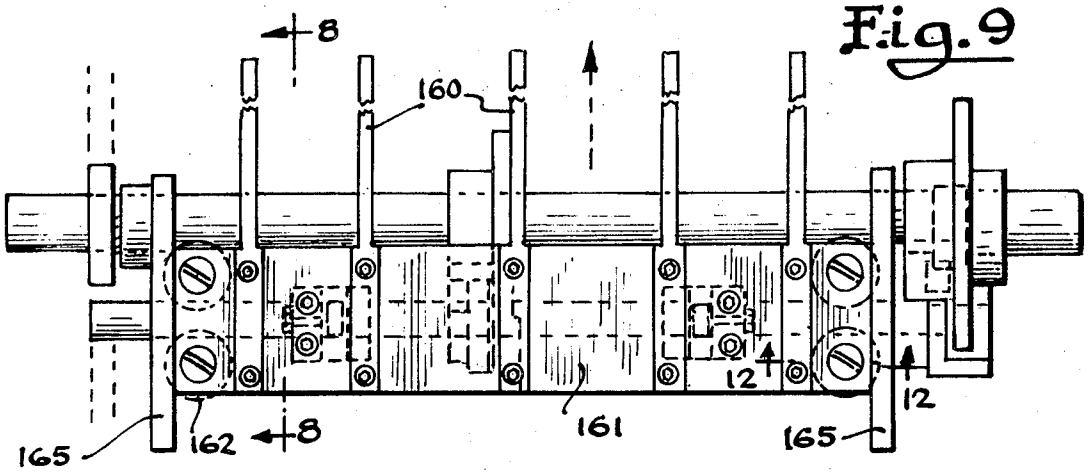
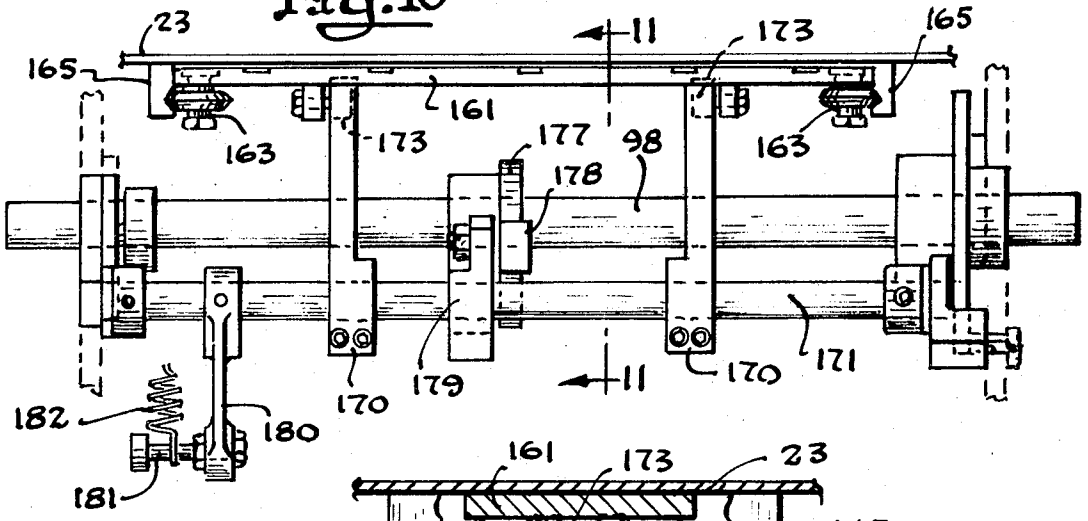


Fig.10



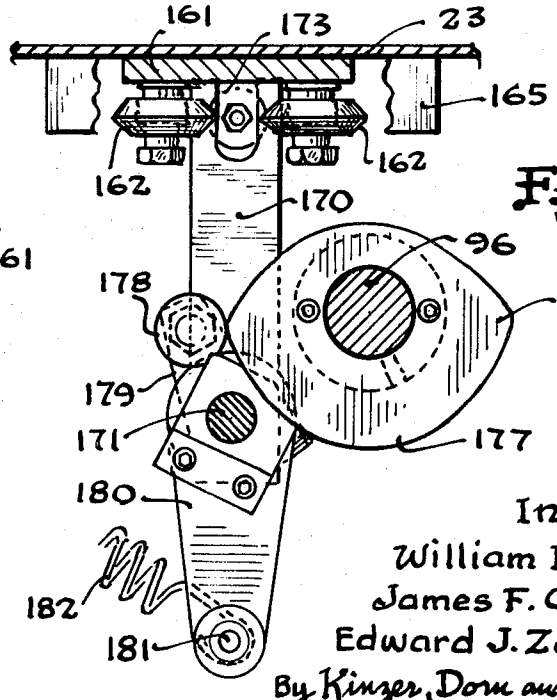


Fig.11

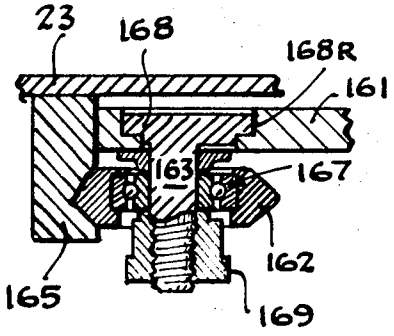
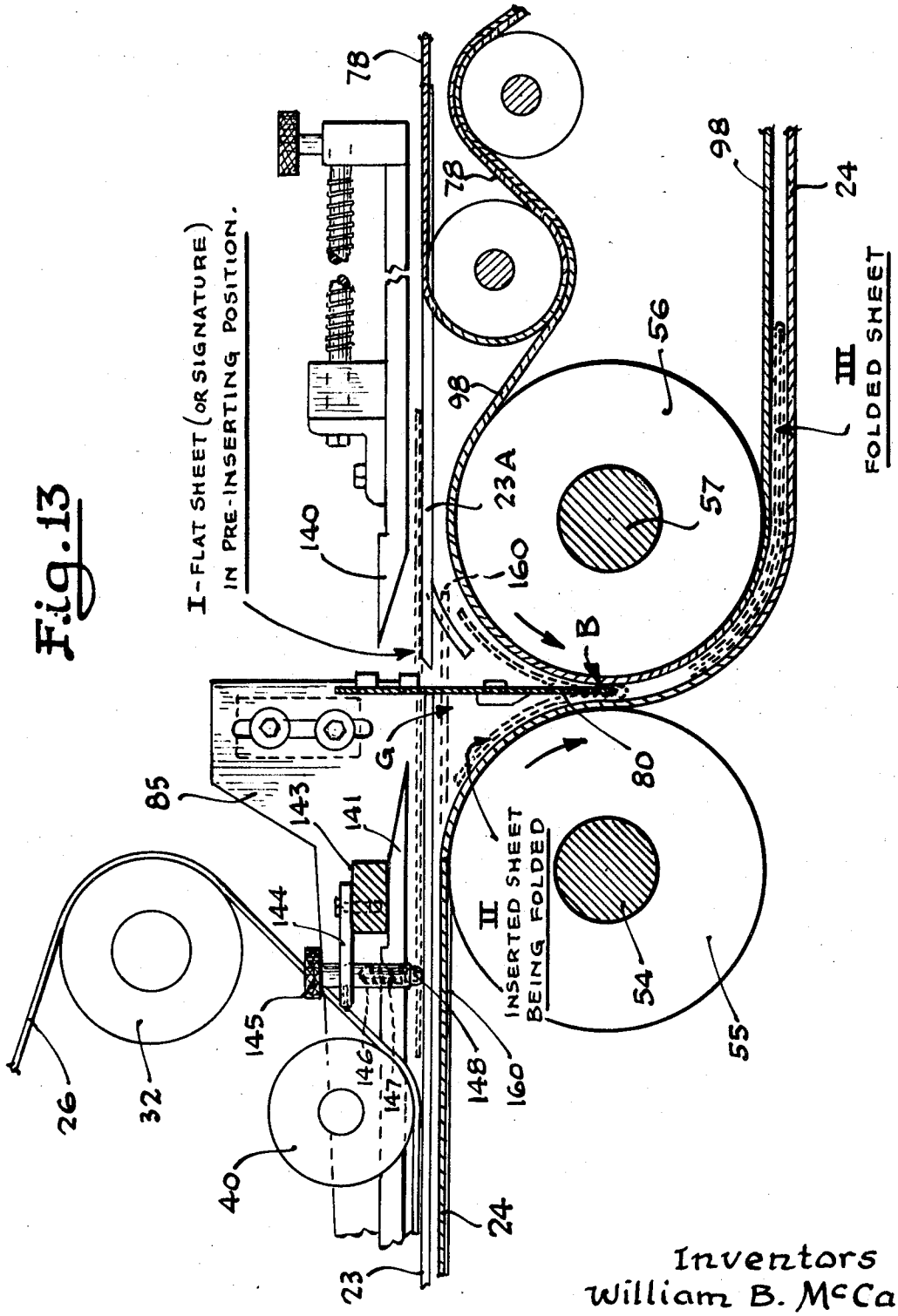


Fig.12

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Fig. 13



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FOLDING MACHINES

This invention relates to a machine for imparting a medial fold to a sheet or signature.

Books such as magazines and the like are composed of signatures which in the most simple form is a folded sheet presenting four pages of text or other printed matter. The signatures are assembled in individual hoppers or pockets and are fed therefrom in the proper sequence onto a conveyor to compose a book. Thereafter the assembled signatures are joined by stitching or gluing.

The signatures may be gathered on a saddle conveyor in which event the signatures are dropped one atop another so that the folded backbones are nested. The nested signatures may be joined by staples driven through the assembled backbones, the staples piercing the signatures colineally with the fold lines.

In another form of signature gathering machine, a flat or side gatherer, the signatures are collected one atop another in a flat state and are joined by staples that pierce the margin adjacent the fold line, forming a book with a so-called square back in contradistinction to a book produced on a saddle conveyor where the back of the book is V-shaped.

In any event the machine of the present invention is converned with folding a sheet, and while one mode of utility is in terms of producing signatures it will be appreciated that the invention is not so restricted.

The sheets to be folded may in fact be a book cover, or it may be an interior signature. Usually a book cover is of relatively hard paper compared to the softer paper which is usually the form of an interior signature. The present machine is constructed to take into account the different folding characteristics of a hard sheet and a soft sheet. Thus a hard cover, if folded on a bend which is too sharp, may break or crack, and therefore one of the objects of the present invention is to avoid this possibility by so constructing the machine as to enable a soft or easy fold to be imparted to a hard sheet while disregarding this possibility in the instance of soft sheets.

The present machine is capable of handling thick signatures which may be fed to the machine, already in a partially folded state. A signature of this character is of course much thicker than a single sheet to be folded, and another object of the invention is to enable a pair of folder rollers to be adjusted to vary the width of the bight or throat which imparts the fold to the signature or sheet.

As suggested above, folding in the present machine is accomplished by a pair of folder rollers. The sheet to be folded is forced to the bight of the folder rollers by an inserter blade which concurrently starts the fold. Prior to being so inserted, the sheet to be folded is located in a pre-inserting position, lying in a plane which spans the gap between the folder rollers. The sheet may tend to sag, resulting in an inaccurate fold, and one of the more important objects of the present invention is to temporarily support the sheet in its pre-inserting position by a reciprocal shuttle, the shuttle being displaced from its supporting attitude just prior to the time the inserter blade strikes the sheet to start the fold. A related object of the present invention is to stretch or render the sheet taut in its preinserting position, since to do so contributes to the attainment of an accurate fold.

Other and further objects of the present invention will be apparent from the following description and claims and are illustrated in the accompanying drawing which, by way of illustration, shows a preferred embodiment of the present invention and the principles thereof and what is now considered to be the best mode contemplated for applying these principles. Other embodiments of the invention embodying the same or equivalent principles may be made as desired by those skilled in the art without departing from the present invention.

In the drawing:

FIG. 1 is a perspective view of a machine constructed in accordance with the present invention;

FIG. 2 is a fragmentary perspective view of the front of the machine, enlarged as compared to FIG. 1;

FIG. 3 is a plan view of a portion of the machine;

FIG. 4 is a plan view of apparatus associated with a sheet stop and a sheet tensioner;

FIG 5 is an elevational view on the line 5—5 of FIG. 3;

FIG. 6 is a sectional view on the line 6—6 of FIG. 3;

FIG. 7 is a fragmentary sectional view of the machine;

FIG. 8 is a detail sectional view of parts associated with the shuttle and being taken on the line 8—8 of FIG. 9;

FIG. 9 is a detail elevation of the shuttle;

FIG. 10 is an end elevation of the shuttle structure;

FIG. 11 is a sectional view on the line 11—11 of FIG. 10;

FIG. 12 is a detail sectional view on the line 12—12 of FIG. 9; and

FIG. 13 is a sectional view on an enlarged scale showing the construction at the folding station.

The folding machine 20, FIG. 1, receives an unfolded sheet, or a partly folded sheet or signature (for further folding) moving along the in-feed path as shown. The sheet is transferred by tape feeders, as hereinafter described, to the folding station. After the sheet is folded, it is delivered for further processing, as for instance delivery to a signature gatherer.

Referring to FIG. 7, in-feed rollers as 22 and 22A receive the sheet to be folded and advance it along a guide and support plate 23 to opposed in-feed tapes 24 and 26, arranged in pairs (see FIG. 3) or even fours which advance the sheet forwardly along the plate 23 in the direction of the folding station. The rear turns of the tapes 24 and 26 are trained around rear pulleys or rollers 28 and 30, FIG. 7. The upper tapes 26 are trained around forward rollers 32, and are tensioned by intermediate idler rollers 34 carried on adjustable arms 35, FIG. 3.

The lower in-feed tapes 24 are presented to grooves in folder roller (55 hereafter) and then extend forward to (idler) pulleys or rollers 36; from thence in a return direction to tensioner rollers 37 supported on an adjusting arm as 37A, thence upwardly about idlers 38 and finally to the rear rollers 28.

A set of forward tensioning rollers 40, FIG. 7, is also provided for the upper in-feed tapes 26. These rollers are supported for rotation by a cross shaft 41, FIG. 3, supported in turn by brackets 42 secured by screws 44, FIG. 7, at the ends of another cross shaft 44A, FIGS. 2 and 3, mounted in slots 45 formed in downwardly and forwardly extending arms 46. The arms 46 are bifurcated, FIG. 7, and are tightened on a support shaft 48

by screws 50. Resultantly, by loosening screws 44 and 50, FIG. 7, the supports 42 may be extended or retracted to displace the rollers 40, thereby to vary the location of the forward bight between the in-feed tapes 24 and 26. This adjustment, for sheet size, assures that the sheet will be moved accurately against the sheet stop, hereinafter described, without significant buckling.

A driven shaft 54, FIG. 7, supports a plurality of rear folder rollers 55, the folder roller 55 being opposed to a like number of forward folder roller 56 carried by a driven shaft 57.

The rollers or tape pulleys thus far described are driven by chains and gears in a manner which is apparent from FIG. 7. Thus, chain 61 drives gears 62 and 63 for the folder roller shafts 54 and 55, and at the same time the tapes 24 are driven as an incident.

Drive shaft 54 carries a gear 66 about which a chain 65 is trained. Chain 65 extends to a gear 68 which drives the shaft 69, FIG. 7, for the in-feed rollers 22. Another gear (not numbered) on this same shaft drives a chain 70 trained about a gear train 71-72-73 for driving shaft 74 which carries each drive pulley as 30 for the upper in-feed tapes 26.

Advantageously, shaft 74 is supported by a pair of arms 75, FIG. 7, pivoted about shaft 76 which carries gear 71, being tensioned clockwise by a spring 77, which allows the assembly to yield to any in-feed jam or overload. The shaft for in-feed rollers 22A is supported in like manner as will be apparent from FIG. 7 by means including arms as 22B, pivoted on shaft 76 and tensioned by a spring 22C to engage rollers 22A with rollers 22. Rollers 22A are carried on a shaft 22D driven by a gear 22G meshed with gear 72.

The folder rollers, FIGS. 7 and 13, are separated at the nearest point by a narrow throat or bight B and at their widest point thereabove by a gap G. The sheet to be folded, in-fed by the tapes to the folding station, spans the gap G so that the leading portion moves on to a support plate 23A on the opposite side of the gap G. In-feeding is continued by the tapes 24 and 26, until the leading end of the sheet is picked up by a pair of tapes 78, FIGS. 3 and 7, which present the leading edge of the in-fed sheet to a stop as hereinafter described.

The sheet to be folded spans the gap G in its preinserting position, and as will be described in detail below, the medial portion of the sheet to be folded is accurately located in centered position above the folding bight B. The sheet is moved from this position into the folding bight by an inserter blade 80 adjustably supported on the outer face of a cross plate 82 in turn supported by a pair of rocker arms 85. The lower edge of the folding or inserter blade 80 is serrated at 80E, and additionally is provided with a pair of needle-like projections of small diameter (not numbered) which actually pierce the sheet when it is struck by the folding edge of the blade 80.

The arms 85, FIGS. 3 and 7, are pinned to the outer ends of a rock shaft 90 extending between and supported by the side plates of the machine. Springs 91, FIGS. 1 and 2, are anchored at the lower end to a stud 92 fixed to the side of the machine, and at the upper end each spring is anchored to a stud 93 on the related arm 85. Hence the springs 91 tend to rock the folder blade clockwise as viewed in FIGS. 1, 2, and 7, but such tendency is resisted and controlled by a pair of cams as 95, FIGS. 2 and 3, carried at the outer ends of a cam shaft 96 having a gear 96G which is turned by chain 61, FIG. 7, each cam 95 bearing on a cam follwer 97 on the outer side of the related folder support arm, FIG. 2.

It will be appreciated, of course, that the reciprocal stroke of the folder blade 80, downward from its retracted position, FIG. 7, is sufficient to move the sheet from its pre-inserting position into the folder bight B. During this movement the fold is of course started, particularly as this is aided by the tensioning means to be described below, and eventually the tapes 24 take over and assure movement of the partially folded sheet into and through the bight. In this connection, and referring to FIG. 7, feed tapes 98 are trained around the forward folder rollers 56 and around rear tensioner rollers 99 and hence cooperate with the tapes 24 in accepting the sheet from the folder blade and moving the sheet through the folding bight or nip B.

Another pair of tapes 100 are trained around the folder roller 56 and the tensioner rollers 99, and these tapes are in contact with the tapes 78 so as to drive the latter about their guide rollers 78A, 78B and 78C.

Rollers 99, for the feed tapes 98, are supported for vertical adjustment so that the gap of separation between the tapes 24 and 98 may be varied for a strong drive or an easy drive of the folded sheet to the point of delivery, FIG. 7. To this end, the rollers 99 are supported for rotation on a shaft 101 extended through vertically elongated slots 102 in the side plates of the machine, FIG. 7. Shaft 101 in turn is supported at each end in a block 102B, FIG. 2. Each block 102B is pinned to the lower end of an adjusting screw 103, extended freely through an opening in a guide ear 103E, fixed to the side plate of the machine. A spring 104 is fitted about the shank of the screw 103 in the portion thereof between the block 102B and the ear 103E so as to allow the rollers 99 to yield to any jam or overload. The end of the screw 103 above the ear 103E is threaded and provided with an adjusting and lock nut assembly 104A and 104B respectively, enabling the position of shaft 101 to be adjusted thereby to vary the separation between the tapes 24 and 98.

It was mentioned above that adjustment of the tensioning roller 40 associated with the upper in-feed belt 26 in part is concerned with properly advancing a sheet of predetermined length to a stop means. The stop means and the associated parts are shown in detail in FIGS. 4 to 6, and specifically the stop is in the form of a bar or blade 105, FIGS. 4 and 6, which, as shown in FIG. 7, is normally in a stop position on the right-hand side of the folder rollers 56.

The stop blade 105 is substantially L-shaped, FIG. 6, being provided with an offset 107 juxtaposed on the upper edge of a support bar 108. The offset 107 is interposed between the support bar 108 and a pair of thumb screws 110 having bosses 112, FIG. 6, at the underside thereof adapted to be tightened against the offset 107 to fix the stop blade in an adjusted position.

The offsets are provided with open-ended slots 112, FIG. 4, such that by loosening the screws the blade may be adjusted uniformly along its length or tilted at an angle, if necessary, to afford the necessary accurate stop edge for the leading edge of the sheet moving across the gap G in the direction of the stop.

The support bar 108, outward of the stop blade 105, is provided with tapped openings 108A, FIG. 4, threadedly related to a pair of elongated adjusting screws 115. The extremities of the support bar 108 are provided

with apertures 108B which fit a pair of guide bars 116. The ends of the screws 115 and the ends of the guide rods 116 are supported in cross supports 117 and 118.

Referring to FIG. 4 the ends 120 of the screws 115 are journalled in the support bar 118, and the opposite ends are rotatably supported in the cross support 117, having extensions outward of the support 117 provided with gears 121 and 122 about which is trained flexible toothed belt 125. The screw 115 having gear 121 is provided with a knob 126, such that by turning the knob 126 both screws 115 may be turned to advance or retract the support bar which carries the adjusting blade 105. As shown in FIG. 2, the cross support 117, at its opposite ends, is fastened to the side plates of the machine, 130.

Advantageously the leading and trailing margins of the sheet in its pre-inserting position are tensioned somewhat, or in any event are held taut to assure that the sheet is properly stretched across the gap G so that the fold may be accurately made, and to this end a pair of spring biased rollers 132, FIG. 3, are superimposed on the tapes 78. Thus the sheet advancing across the gap under the direction of the in-feed tapes 24 and 26 is forced between the rollers 132 and the opposed tapes 78 thereunder which clamps opposite sides of the sheet at the leading end.

Referring to FIGS. 4 and 6, each roller 132 is rotatably supported on a horizontal pin 133, and each pin 133 in turn is carried on a support arm 134. The support arm 134 in turn is carried by a support pin 135 threadedly mounted in a bracket 136 fastened to the cross support 118. Each pin 135 had an adjusting knob 135K and a lock nut 135N. A torsion spring 138 is mounted on the pin 135 and is effective between arm 134 and knob 135K to urge the related roller 132 by slight spring tension downward into contact with the tapes 78. Washers 139 are mounted on each pin 135 between arm 134 and the bracket 136. By turning knob 135K in or out as the case may be, to vary the force of spring 138 on arm 134, the effectiveness of the spring may be regulated, thereby determining the force of the rollers 132 bearing on the sheet.

It is appropriate to note in connection with the advancement of the sheet across the gap G that a plurality of guide fingers 140, FIGS. 4 and 7, overlie the support plate 23A thereby constraining the sheet for straight forward movement toward the stop 105. In like manner, guide fingers 141, FIGS. 3 and 7, spaced slightly above the support plate 23, are arranged to constrain the sheet in the course of its movement across the gap G as hereinafter described.

Referring to FIGS. 3 and 13, a tie bar 143 spans and is fastened to the side plates 130 and a pair of brackets 144 and fastened thereto in spaced relation as a convenient mode of presenting additional sheet tensioners for the trailing portion of the sheet. To this end each bracket 144 supports a hollow housing 145 provided with a vertically oriented chamber 146 in which is disposed a compression spring 147 applying pressure to a ball 148 normally bearing on the support plate 23. The spring 147 is of such nature as to press the ball 148 lightly against the plate 23 but not with a force of such order as to prevent the passage of the sheet therebetween, and when the trailing end of the sheet is therebetween it is clamped on opposite sides by the ball 48 and plate 23. Nonetheless, when a sheet is finally against the stop blade 105, both the rollers 132 and the balls 148 serve to tension the sheet sufficiently to in effect hold the sheet in a true horizontal plane at the time the inserter blade is effective to force the sheet toward the bight of the folder rollers.

The folder roller 56, supported on the shaft 57, are arranged for adjustment toward and away from the opposed folder rollers 55. This enables the folding bight to be adjusted both for sheet thickness and to vary the folding pressure, inasmuch as a hard sheet ought not to be folded so forcefully as softer sheets.

To this end, and as shown in FIGS. 2 and 7, shaft 57, at each end, is rotatably supported by an arm 150, and at its lower end arm 150 is pivotally supported on a pin 151, FIG. 7. The upper end of the arm 150 is fastened to the bifurcated end of a link 152, and link 152 extends through an aperture in an ear 153 extending outwardly from the side plate 130 of the machine. The end of link 152 opposite the bifurcation is provided with adjustable lock nuts 154. A compression spring 155 surrounds the portion of link 152 lying between ear 153 and the bifurcated end of the link. By loosening or tightening the lock nuts as the case may be, link 152 may be varied, thereby shifting the support arm as 150 incidental to narrowing or widening the bight B. Spring 155 imparts a degree of yieldability to the folder rollers 56.

In order to obviate the possibility that the leading portion of the sheet may sag into the bight B as it crosses the gap G, a reciprocal support or shuttle is provided under and in accordance with the present invention to support the sheet during this transitional period. Referring to FIGS. 9 through 12 the preferred form of the support includes forwardly projecting fingers 160 fastened to a shuttle 161. The fingers 160 are relatively thin and are aligned with guide grooves in the folder rollers 55 to reciprocate therein. Means are provided to move the shuttle and the fingers 160 forwardly to an active position in accordance with the need to provide temporary support for the sheet, while withdrawing the fingers 160 to their retracted position at the time when the folder blade commences its operative stroke.

The shuttle 161 is in the form of a rectangular plate and the opposite ends thereof are associated with guide means which confine the shuttle to the required reciprocal path. Thus associated pairs of guide rollers 162 are supported for rotation on journal pins 163 at the ends of the guide rails 165, and the guide rails 165 are secured in depending relation to the underside to the guide plate 23 as shown in FIG. 12. To assure smooth action and little friction, roller bearing races 167 are interposed between the rollers 162 and the journal pins 163.

The journal pins are eccentric stubs, depending from a head 168, seated snugly in a recess 168R forward in the cross support 161. By loosening a nut 169, threadedly attached to the lower end of the eccentric stub 163, the head 168 may be turned, thereby tightening or loosening the fit between the guide roller 162 and the guide rail 165.

In order that the shuttle may be reciprocated in an accurately timed relationship, shuttle control means of a cam operated type are provided. To this end a pair of shuttle support arms 170, FIG. 10, are fastened to a rock shaft supported by and extending between the side plates of the machine as shown in FIG. 10. The upper ends of the arms 170 are bifurcated as shown in FIG. 11 and embrace rollers 173 supported at the underside

of the carrier or shuttle **161** as shown in FIG. **10.** Thus when the rock shaft **171** is oscillated the shuttle support carrier **161** travels in a horizontal path in a manner now to be explained.

Cam shaft **96,** FIG. **11,** carries a shuttle control cam **177** associated with a cam follower **178.** The cam follower **178** is carried at the upper end of an arm **179,** and arm **179** is adjustably secured to the rock shaft **171.** Shaft **171** is spring biased so that the follower **178** is normally held against the cam **177,** and referring to FIGS. **10** and **11** and arm **180** is secured to the rock shaft **171,** depending therefrom. The lower end of arm **180** is provided with a stud **181** on which the lower end of a spring **182** is anchored, the upper end of the spring (not shown) being suitably anchored so as to apply tension to arm **180.**

As shown in FIG. **11** cam **177,** which controls operation of the shuttle, is carried on the cam shaft **96** and has two diametrically opposed lobes **177L.** When a cam lobe **177L** is presented to the follower **178** the shuttle support arm **161** is reciprocated rearwardly to dispose the support fingers **160** in their ineffective position. This would be at a time when the folder blade is undergoing its downward or operative stroke. Then as the folder blade attains its upper or retracted position the dwell or low part of cam **177** is presented to the follower **178,** whereby the finger support shuttle commences its forward stroke as impelled by spring **182** whereby the fingers **160** move forwardly in the guide grooves provided therefor in the folder rollers **55** at a time when the next sheet to be folded is traversing the wide gap G, and in fact the support fingers **160** span the gap G before the leading edge of the next sheet to be folded reaches the gap G. The support fingers **160** are withdrawin rearwardly under control of cam **177** in the course of the downward stroke of the folder blade, and are completely withdrawn or retracted at the time the folder blade engages the medial portion of the sheet incidental to driving it into the folding bight B.

It will be seen from the foregoing that under the present invention a sheet is folded by a pair of folder rollers, provision being made for adjusting the dimension of the folding bight or nip between the rollers accordingly as the sheet is of such nature as to require a soft fold or a hard fold. The sheet is delivered to the folder rollers by an inserter located above the gap between the rollers. The sheet to be folded, spanning the gap, is stretched to a taut state by tensioners acting as clamps on both the leading portion and the trailing portion. This state of tension prevails when the inserter engages the sheet, and consequently the sheet is in condition to have a sharp fold imparted thereto as the inserter drives the tensioned sheet into the folding bight presented by the folder rollers.

The sheet to be folded is driven forwardly by endless feed bands or tapes, and these are adjustable with respect to an adjustable stop on the far side of the folding bight so that the in-feed tapes and the stop may be adjusted to comply with the prevailing circumstances so far as concerns sheet length. As the sheet traverses the gap between the folder rollers, moving beneath the inserter means, temporary support is lent thereto by means of the support shuttle **160** and its fingers.

Hence, while we have illustrated and described the preferred embodiment of our invention, it is to be understood that this is capable of variation and modification.

We claim:

1. A machine for folding sheets comprising a pair of opposed folder rollers supported for rotation in opposite directions on horizontal axes at a folding station and defining a narrow vertically oriented folding bight between which a sheet is inserted for folding, means for in-feeding the sheet in its flat unfolded state along a feed path to a pre-inserting position in a plane spanning the gap between the rollers, the sheet so fed passing a first one of the folder rollers and then the second one, an inserter blade spaced opposite the flat sheet in its pre-inserting position, means to impart an insertion stroke to the inserter blade during the extent of which the blade engages the sheet in its pre-inserting position to start a fold therein and concurrently inserts the partly folded sheet in the bight between the rollers which are to complete the fold, means to return the inserter blade to its starting position following an insertion stroke, a stop in said feed path located behind said second one of the rollers passed by the in-fed flat sheet, said stop being in position to engage the leading edge of the sheet to be folded and accurately locate the sheet relative to the inserter blade, a reciprocal shuttle presenting a reciprocal sheet support in said feed path for bridging the gap between the folder rollers to lend temporary support to the in-fed sheet as it moves across said gap toward said stop, a fixed sheet support plate in advance of the first folder roller and on which the trailing part of the sheet is disposed when the leading edge engages the stop, means located on opposite sides of the folding bight to apply tension to the leading and trailing portions of the sheet spanning the folding bight, said last-named means including additional sheet feed means located between said stop and said second folder roller and gripping opposite sides of the sheet to feed the sheet toward said stop and said tensioning means further including means pressing the trailing part of the sheet against said sheet support plate with a predetermined amount of pressure while said additional sheet feed means presents the leading edge of the sheet to said stop whereby said pressing means and said additional sheet feed means cooperate to stretch the sheet taut in its pre-inserting position when its leading edge is against the stop as aforesaid, means for withdrawing the shuttle before the inserter blade engages the sheet to be folded, said addition sheet feed means comprising a feed tape and an opposed roller engaging opposite sides of the sheet, and said pressing means comprising a spring biased member and means for regulating the effect of the spring.

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