

Feb. 12, 1935.

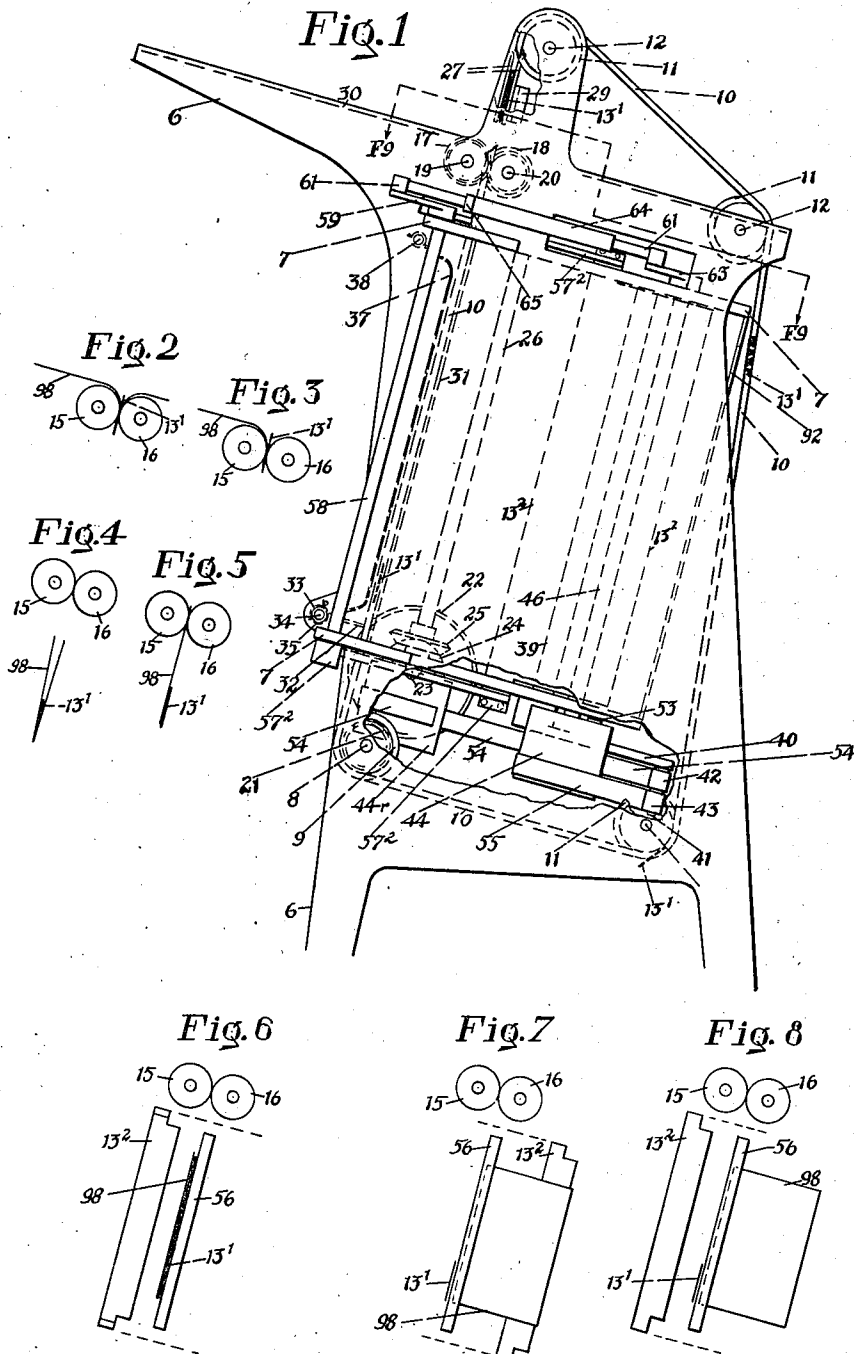
W. J. NEIDIG

1,990,495

FOLDING MACHINE

Filed June 20, 1932

3 Sheets-Sheet 1



Inventor:
William Jonathan Heiding

Feb. 12, 1935.

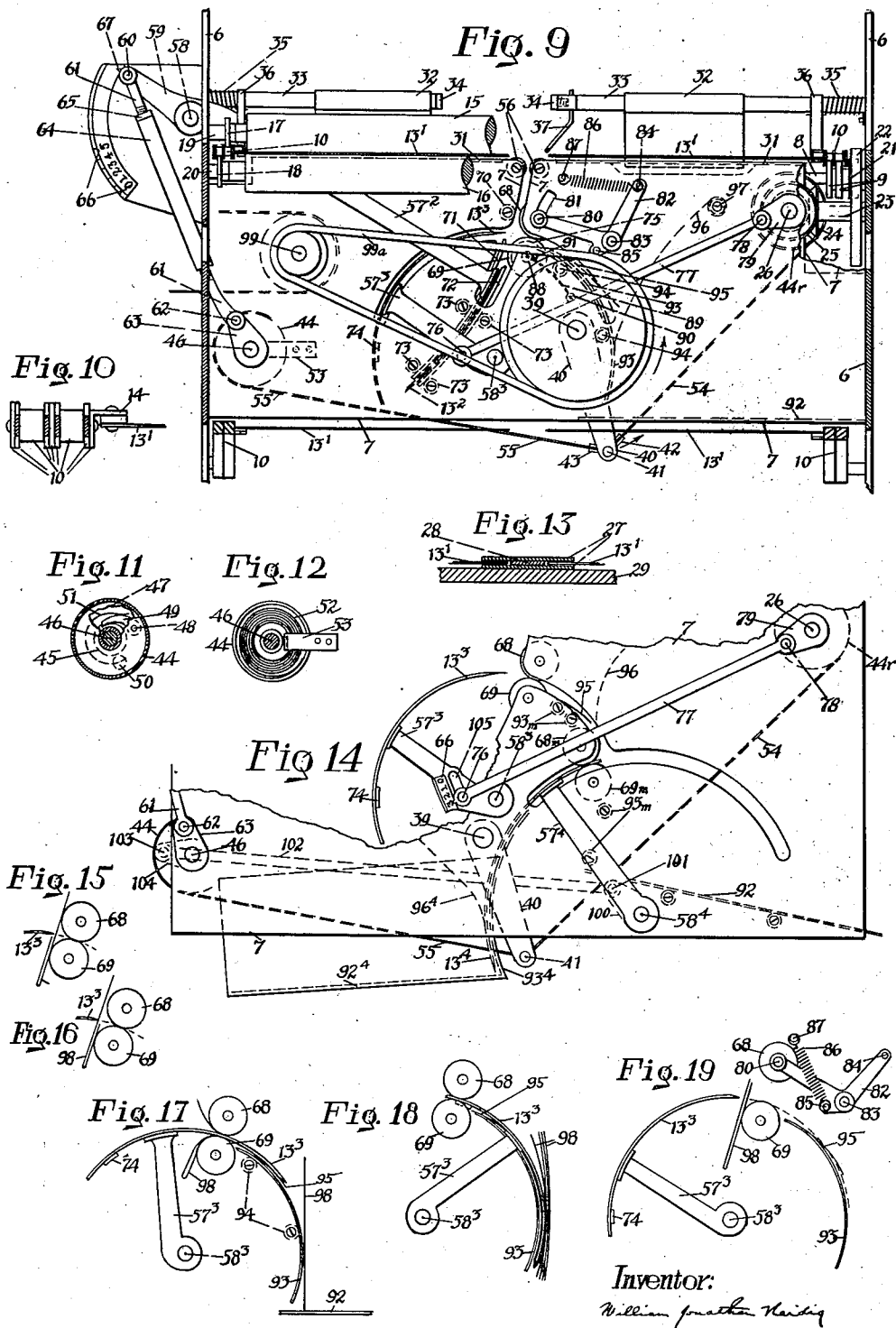
W. J. NEIDIG

1,990,495

FOLDING MACHINE

Filed June 20, 1932

3 Sheets-Sheet 2.



Feb. 12, 1935.

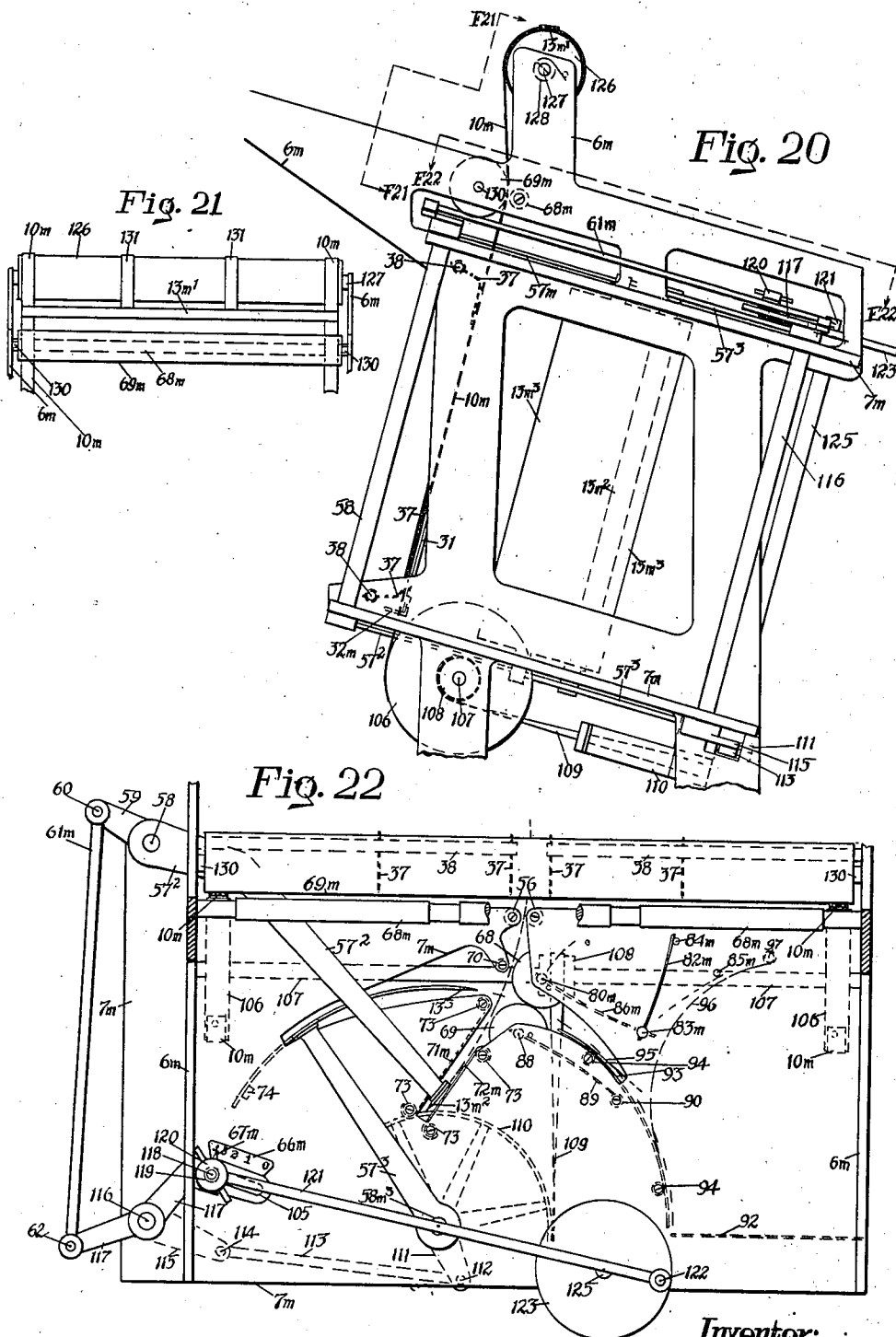
W. J. NEIDIG

1,990,495

FOLDING MACHINE

Filed June 20, 1932

3 Sheets-Sheet 3



UNITED STATES PATENT OFFICE

1,990,495

FOLDING MACHINE

William Jonathan Neidig, Chicago, Ill.

Application June 20, 1932, Serial No. 618,131

31 Claims. (Cl. 270—85)

The invention relates to mechanisms designed to fold various sizes and weights of paper such as are commonly employed in commercial job folding or in office folding.

5 In usual jobbing folders of the knife type a cam-operated knife strikes a positioned sheet into a fold between pressure rolls, which in this use act as folding members. Such a knife is at once retracted and does not act advancingly upon the sheet. In order that it may be retracted without carrying the sheet with it, both pressure rolls are gear-driven to give them a stripping friction greater than that between the sheet and the knife. Thereafter the rolls become sheet-advancing agents, and in connection with other agencies such as tapes assist in bringing the sheet into the position required for its further folding, where a new knife will strike it between a new pair of rolls. In many cases this new sheet position is not readily alterable, or not alterable at all; in others the sheet is brought to a stop in a manner hard to control, against a gauge from which it tends to rebound, and the gauge is not readily accessible for adjusting.

My invention is largely directed at eliminating the difficulties of adjustment involved where the folds and folding are frequently changed.

10 The invention comprises novel constructions some of which perform functions new in the art. One of these is a novel construction combined with a follow-through sheet-advancing folding blade, that is to say, a blade that follows through with the sheet after folding it instead of being retracted, and has as a purpose the varying of the next-stage folding action through varying the advance of the blade. This is believed to be new. The construction admits of adjustments having novel uses. Through one such adjustment the sheet can be presented to the next folding blade so as to be engaged near its leading edge for edgewise forwarding, without being folded thereby, and without being detoured out of the operative cycle. Through another such adjustment the sheet may be presented to the next folding blade for engagement near its rearward edge for similar forwarding. One of such switching actions continues the forwarding without disturbing the original lay of the sheet, whereas the other turns the sheet over and forwards it with its original leading edge trailing. Through still another such adjustment the sheet can be advanced by the follow-through blade to a point beyond the path of the next-stage blade, or further still, and thus be switched

entirely out of the operative cycle. Yet another such adjustment results in changing the position of the next-stage fold on the sheet, and since such fold falls parallel to that last made, in changing the separation of two parallel folds. The manner of accomplishing this result is new and very useful in practice. In the case of all these functions, the adjustments can be made convenient to hand, and if desired while the folder is running.

15 In addition to these novel constructions my invention embodies the use of indicating devices to indicate to the operator what the effect of a given adjustment will be, so that he can make advance adjustments for a desired fold or other purpose with speed and certainty, instead of by trial and error. These usually comprise a pair of relatively movable indices or indicators, with symbols or such other visual assistance added as will be of value to the operator. Ordinarily the next-stage folding line is found of most convenience as a datum. The indicating pair may be adjustably movable and operatively stationary with respect to each other, or they may be operatively movable. Such use of indicating devices is new in the art.

20 Other objects of the invention include the supplying of an improved and simplified stacking means, whereby a specially mounted follow-through blade is used to stack the folded sheets against a support without employing any other moving part. They include also the supplying of an improved means for entering or forwarding a sheet past the first-stage folding devices without sustaining a fold therefrom. And they include the supplying of a novel follow-through blade of divided construction able to be discharged of its folded sheet over the unobstructed interior ends without change of operative position, so that retraction of it before discharging the sheet is not needed.

25 A further object of the invention is to supply an improved means for flattening the folds on sheets bearing unset folds. The invention in this aspect comprises a special form of follow-through blade adapted to lie between the folds to be flattened, or sometimes against one side of a fold, so that an incipient buckling of the sheet is able to flow off in contact therewith into normal smoothness. Especially does such special construction prove of advantage, if the fold to be flattened is a longitudinal one. The usual cam-struck knife and gear-driven rolls stripping the sheet therefrom cannot be depended on to flatten such folds without wrinkling the sheet.

One reason is that paper laid against paper tends not to flow readily under pressure. Another is that such rolls tend to advance the exterior layers of a fold over the blade-retarded interior layers, and even a slight slip between the outer and inner shells will multiply when folded paper is advanced longitudinally, paper-to-paper, between pressure rolls. The follow-through blade advances the sheet from within the fold, and its construction does not permit of a slip between the outer and inner shells in entering. This use of a follow-through construction is believed to be new.

It is a further object of the invention to supply constructions for the purposes mentioned able to be adapted according to their nature for use in any one or all of the several folding stages, or in connection with usual folding mechanisms, for such purposes and in such use.

Another object of the invention is to supply a sheet-positioning blade of an improved form especially suited to the first folding stage, although not limited thereto, namely attached upon flexible carriers such as chains or straps, for certain uses where a usual cam-struck knife and rolls would be less effective even here. Other objects are as described and claimed.

I attain my several objects by the mechanism illustrated in the accompanying drawings, in which—

Fig. 1 is a view in side elevation of one of the embodiments of the invention, certain parts being omitted and certain structure being partly broken away. Fig. 2 illustrates diagrammatically the folding action of the follow-through blade, and Fig. 3 the entering action of the blade upon an unfolded sheet. Figs. 4 and 5 are diagrammatic views showing later positions of the blade and sheet illustrated in Figs. 2 and 3 respectively. Fig. 6 illustrates diagrammatically the folded sheet of Figs. 2 and 4 as positioned by the blade for further folding. Fig. 7 and 8 are diagrammatic illustrations of said sheet as folded and positioned in turn by the second-stage follow-through blade. Fig. 9 is a top view, partly in section, on the line F9—F9, Fig. 1, of the embodiment, the feed board being removed and certain parts in the foreground being omitted for the sake of clearness. Fig. 10 is a view on an enlarged scale, partly in section, of a detail of construction. Fig. 11 is a detail view, partly in section, of the lower end of a ratchet drum shown in Fig. 9, and Fig. 12 is a detail view of the nearer end of the same. Fig. 13 is a detail view in section on the line F9—F9, Fig. 1, of the foreground parts omitted in Fig. 9. Fig. 14 illustrates the ease with which another follow-through folding stage can be added to the mechanism shown in Figs. 1 and 9, with certain omissions of parts already described. Figs. 15 and 16 are diagrammatic views showing the position of the sheet in the case of two common folds about to receive the completing fold. Figs. 17 and 18 illustrate the fold-flattening and stacking action of the mechanism. Fig. 19 illustrates the position of a sheet when advanced to the next operative position without folding, if use is made of my retractible construction. Fig. 20 is a view in side elevation of another embodiment of the invention, certain parts being omitted for the sake of clearness. Fig. 21 is a reduced scale view of the same on the line F21—F21. Fig. 22 is a top view of the embodiment, on the line F22—F22, Fig. 1, but with

the feed-board removed, and with certain parts shown in section.

Similar symbols of reference refer to similar parts throughout the several figures. The numerals 0, 1, 2, 3, 4, and 5 are employed for convenience as indices in connection with certain adjusting devices described later.

The embodiment of the invention shown in Figs. 1 to 13 and Figs. 15 to 19 is described as follows:

This embodiment embraces three folding stages, each employing a follow-through blade. The first-stage blade has a revoluble operation, being advanced intermittently in an irregular orbit by synchronized chains, and is parted centrally for discharging purposes. The second-stage and third-stage blades have a reciprocating action. The invention is not limited to the use of such mechanism, nor to the use in any particular folding stage of a follow-through blade, it being possible to substitute therefor any usual folding mechanism, where the use permits.

The two side-frames, indicated at 6, are connected by two plate-like cross-frames 7. Side-frames 6 have journaled in them the ends of shaft 8, on which are attached within said frames two sprocket-wheels 9, adapted to engage drivingly with two roller-chains 10, said chains being supported at other points by idle wheels 11 journaled on pins 12 on frames 6. The chains serve as a flexible carrier for follow-through blade 13¹. Said blade is constructed in two parts in duplex each being attached at the outer end upon one or the other of the chains, in such manner that the inner ends are separated. The construction is shown in detail in Fig. 10, the side-plate 14 of one of the chain links having a bracket-like extension upon which the blade is attached near the pitch-line of the chain. The construction at the right-hand chain (Fig. 9) is the same, except that the blade extends to the left from it. I prefer to employ a usual double-roller chain, and attach the blade to a usual removable link, but the type of carrier and manner of attaching are immaterial. In order to give the blade a shorter movement, I repeat the construction, in this case three times, so that the chains are given a four-stage advance instead of a single one. The chains are driven from shaft 8, as has been said, and serve as carriers for blade 13¹. They also serve to engage rotatably upon revoluble folding members 15 and 16 through sprocket-wheels 17 and 18 attached respectively upon axles 19 and 20 of the same, journaled in side frames 6. The purpose of the construction is to supply an alternative sheet-advancing means for use in entering and advancing an unfolded sheet, members 15 and 16 being spring-pressed together in any usual or approved manner, and having the functions of the usual folding rolls, except that they are not required to strip the sheet from a retracted blade. Shaft 8 is driven through toothed wheel 21 attached thereon, a suitable toothed wheel 22 journaled on pin 23 on side frame 6 meshing therewith and being driven in turn by the attached miter gear 24 meshing with miter gear 25 attached on shaft 26. The relation of the several toothed wheels and sprockets is such that for each revolution of shaft 26 chains 10 will be advanced one-fourth of their length. Blades 13¹ receive adjacent support at the moment of meeting the sheet from top and bottom guides 27, separated by block 28 in a manner to form a channel for the ends

of the blades. (Figs. 1 and 13.) The guides are supported upon a cross-beam 29, attached at either end upon frames 6.

Other associated structure is indicated as follows: A usual feed-board to assist in entering the sheet is indicated at 30, and paper-tables at 31 attached upon cross-frames 7 to support the sheet after passing between rolls 15 and 16. The sheet upon receiving a fold at said rolls is positioned by blade 13¹; but an alternative positioning means is provided for use when a sheet is entered unfolded, namely retractible end-stops 32. These are attached upon sleeves 33, which are journaled upon inwardly projecting shaft-like pins 34 attached upon side frames 6, springs 35 acting to hold said end-stops in operative position against the end of paper-tables 31. The end-stops are retracted to permit the advance of blades 13¹ by levers 36 attached upon sleeves 33, said levers being engaged by the extensions of side-plates 14 of the chain-links before described. Provision is not made for a backing-up movement, because in this embodiment the chains remain stationary if the mechanism is backed. If the sheet is folded and advanced by blades 13¹ friction means are employed to prevent its displacement by gravity, one of the pins 34 having attached upon it one end of a guard 37, the other end of said guard being carried upon an inwardly projecting pin 38 on frame 6. The guard may be repeated as in Fig. 22 to afford additional friction. The friction in this case is supplied by the guard or guards on one side of the sheet and paper tables 31; on the other, the resilience of the sheet acting to press it against the same. The guards serve also to prevent the buckling of the sheet in steep positions as shown.

The chains are advanced intermittently by the following mechanism: Cross frames 7 have journaled in them a driving shaft 39, the lower end of which has attached upon it arm 40, bearing the downwardly-extending pin 41, on which blocks 42 and 43 are independently journaled. Shaft 26 before mentioned has journaled on the lower end of it an open-ended drum 44, the lower portion of which partially houses a one-tooth ratchet-wheel attached upon said shaft. The construction will be understood from a description of the similar drum 44, shown in detail in Figs. 11 and 12, the ratchet-wheel being indicated at 45, in this case attached upon shaft 46, upon which said latter drum is journaled. A central wall of said drum, indicated at 47, bears downwardly projecting pin 48, on which is journaled pawl 49, and it bears also a downwardly-projecting pin 50, on which is attached one end of spring 51, the other end of which acts to press the pawl into engagement with the ratchet-wheel (Fig. 11). The nearer end of said drum (Fig. 11) houses the attached helical spring 52, the other end of which is attached upon the downwardly-extending end of support 53, attached in turn upon the lower cross-frame 7. The arrangement is such that drum 44 through the pawl-and-ratchet connection will act to rotate shaft 46 in a direction opposite to clockwise, and in turn will be rotated backwardly upon said shaft by spring 52 when its driving force is withdrawn. The construction of drum 44r and its associated parts is the same, except that in this case the pawl-and-ratchet-rotation of shaft 26 is arranged to be in clock direction and the pull of the spring tends to rotate the drum in a direction contrary to clockwise. Drum 44r is rotated from shaft 39, through

a strap or belt 54 attached at one end upon its periphery and at the other upon block 42. Drum 44 is likewise rotated from shaft 39, through strap 55 attached at one end upon it and at the other upon block 43. Shaft 46 on which the latter drum is journaled is itself journaled in cross-frames 7. The construction gives an alternating intermittent rotation to shafts 26 and 46, and through shaft 26 intermittently advances chains 10. I will be understood that the circumference of drums 44 and 44r is such that each will receive one full revolution at each revolution of shaft 39.

For producing the second fold I employ in this embodiment of the invention another following through blade, indicated at 13². The form and action of this blade are somewhat changed from those of blade 13¹, as is also the form of the cooperating folding members. Instead of striking the sheet between revolving pressure rolls, blade 13² strikes it between stationary folding members 56 placed adjacent to its path on either side. Folding members 56 in this case take the form of parallel rods, and they serve also as posts or struts to separate cross-frames 7. It will be noted that if they were removed, the approached inner edges of paper tables 31 would act as folding members, or in default of these, adjacent structure later to be described would so act. The sharpness of the fold produced by blade 13² is not critical, in this embodiment, since the fold produced thereby is flattened later. After striking the sheet between folding members 56, blade 13² carries it forward to the end of its throw in an advancing action, where it leaves it in the control of suitable structure in the required position to sustain the following fold. Such position can be readily varied, obviously, by varying the extent of the throw of blade 13² downwardly.

The construction is described as follows: Blade 13² is carried upon arms 57² attached upon either end of shaft 58, which is journaled between said arms in cross-frames 7. One of said arms has an extension 59 bearing a pin 60, on which is journaled one end of a turnbuckle rod 61, the other end being journaled on pin 62 on arm 63 attached upon shaft 46. The rod 61 is constructed with separable ends having right-hand and left-hand threads for engagement with the suitably threaded turnbuckle sleeve 64, so that when the sleeve is rotated the distance between pins 60 and 62 is changed. A lock-nut 65 locks the sleeve against shifting. The arrangement is such that according as rod 61 is shortened or lengthened by said sleeve, blade 13² will carry the folded sheet a shorter or longer distance across the next folding line. This distance may be indicated by indices 66, carried on an extension of cross-frame 7, through the cooperation of pointer 67 on arm-extension 59. The turnbuckle construction alters the angular position of blade 13² with respect to the folding mechanism, but not its angle of throw. Its downward throw may be varied also by varying the angle of throw, as shown in Figs. 14 and 22, to be described later.

The edge of blade 13², attached upon arms 57², describes an arc, and the blade in this embodiment is shaped to operate in an arc. It is narrowed beyond arms 57² so as to work between cross-frames 7. The devices acting to hold the positioned sheet in place after the withdrawal of the sheet-positioning blade are stationed in this embodiment on either side of the path of the blade. Preferably they act by friction, in this case the spring of the sheet itself supplying the

frictional force. Folding members 56 act frictionally upon the sheet. Pressure-rolls 68 and 69, to be described later in connection with their other functions, likewise so act, since they remain stationary until the sheet passes into the control of the next folding blade. Post or strut 70, attached at either end to cross-frames 7, is so positioned adjacent to the paper path as to act frictionally upon the sheet after its positioning. The sheath-like plates 71 and 72, between which blade 13² inserts the sheet, assist in holding it in place; they are supported upon struts 73, attached at either end upon cross-frames 7. It will be understood that the friction required is small, the folded sheet tending to spring away from the blade, and that in some positions of the mechanism where the force exerted by gravity is greater it may be increased at need by roughening the surfaces involved, or by spring pressure, as in another situation herein.

The third folding blade in this embodiment is indicated at 13³. Like the others it is of follow-through construction, acting both as a folding means and as a sheet-advancing and positioning means. It also has a fold-flattening function. It cooperates with folding members 68 and 69, which in this case are revolvable, first by striking the sheet between them in a fold, if such is required, and then by advancing the sheet between them in a fold-flattening action, as between pressure rolls, said members thereupon acting to flatten the preceding folds. Neither of these functions necessarily requires members 68 and 69 to be revolvable. The revolvable construction is preferred here because it enables one or both of the members to assume an alternative sheet-advancing function, in association with blade 13³, where the sheet is required to be advanced without folding. The positioning function of blade 13³ is two-fold; like blade 13² it acts from within the fold to position a sheet folded by it, in this case upon the stacking-board, and it acts alternatively to position a sheet not so folded in an engagement with either its rear or leading edge after the sheet has been advanced. In the first case it acts positively to thrust the folded sheet behind the sheets stacked earlier. In the second case it makes room for the unfolded sheet to be advanced behind its thrust, and then positions it.

Blade 13³ is carried upon arms 57³ attached on shaft 58³ journaled in cross-frames 7. Like blade 13² it is arc-shaped and suitably narrowed to play between frames 7, and its length is such that it remains in engagement with one or both of folding members 68 and 69 to the end of its folding stroke. Rearwardly it bears projections 74 having a path through grooves 75 in member 69. In some uses the projections are not required. They act upon the rear edge of an unfolded sheet to position it, and are useful also to carry such a sheet beyond the point at which it might be engaged by member 69 on the backward throw of the blade. Blade 13³ is operated through pin 76 on the nearer of the carrier arms 57, and a rod 77 journaled on said pin at one end, the other end of said rod being journaled on pin 78 carried by arm 79, which is attached upon the upper end of shaft 26 previously described.

Revolvable folding members 68 and 69, either one or both, are rotated solely by blade 13³, each being yieldingly pressed against said blade during its folding stroke, except when the one is retracted as in Fig. 19. They cooperate with the blade like ordinary pressure rolls in folding a sheet struck between them, but in addition they

seal or flatten against the blade such preceding folds as are not already sealed, and they cooperate with the blade in an alternative sheet-advancing action required when the sheet is advanced without folding. They are described as follows:

Folding member 68 is preferably constructed having both ends of its axle 80 projecting through slots 81 in cross-frames 7, the axle being journaled outwardly of the frames in arms 82, which are journaled in turn upon pins 83 on frames 7. Each of said arms bears on either side of its axis pins 84 and 85, adapted to receive the ringed end of coiled springs 86, the other end of said springs being attached upon pins 87 on cross-frames 7. When the springs are connected to pins 84, as in Fig. 9, folding member 68 is pressed toward folding member 69, but when the springs are connected to pins 85, as in Fig. 19, folding member 68 is retracted into inoperative position, slots 81 limiting the movement in both directions. Folding member 69 is preferably constructed having a fixed or non-rotating axle 88, carried at both ends upon springs 89 in such manner as to be pressed thereby toward folding member 68. Springs 89 are attached upon cross-frames 7 by inwardly-projecting pins 90, the yielding movement of member 69 being limited by inwardly projecting pins 91 on frames 7. The purpose of the retractable construction of member 68 is to facilitate entering an unfolded sheet upon member 69. Such a sheet may be entered in most cases without its use, but the sheet position required is somewhat critical.

The sheets thus folded are effectively stacked by the same mechanism. Associated with stacking-board 92 in a rearward sheet support 93 on posts 94, in this case having the form of a plate curving away from the edge of the sheets supported thereby, so that the sheet entered will tend to straighten upon it when the blade is withdrawn and leave its original path unobstructed, to facilitate the positioning edgewise of a new sheet behind it. Springs 95 attached on said support project slantingly into the path of blade 13³; they serve to insure the absence therefrom of interfering sheet-edges, and also assist in holding a positioned sheet in place against the withdrawing friction of the positioning blade. A further spring 96 on post 97 may be employed to hold the stacked sheets upright. The invention is not limited to the use of constructions of any particular form or type for any of these purposes, and in some uses some of them will not be required.

The sheet is indicated at 98 throughout the several figures. Shaft 39 is shown as driven from pulley shaft 99 through chain 99a, but the driving devices form no part of my invention.

The mechanism operates as follows: Figs. 1 and 9 show the several parts in the position assumed at the end of the stroke of blade 13², midway of the period of rest of blade 13¹. As shaft 39 is rotated, strap 55 rotates drum 44, and through the pawl-and-ratchet connection, shaft 46, whereupon rod 61 acts to withdraw blade 13² into its position of rest. The operator now turns sleeve 64 until a desired index numeral comes opposite pointer 67, positions a sheet on the feed-board, and causes shaft 39 again to be rotated, whereupon, since pin 41 on arm 40 has reached the end of its stroke, strap 55 is slackened and strap 54 begins rotating drum 44r, thereby acting to rotate sprockets 9 and advance chains 10. This action carries blade 13¹, attached on the chains, edgewise against the sheet, which is carried thereby between folding members 15 and 16

in a fold and advanced down paper tables 31 to the end movement of the blade, where it is frictionally held in place by the structure earlier described, including guard 37. The further rotation of shaft 39 now causes strap 54 to slacken and strap 55 to begin rotating drum 44, and through it shaft 46, thereby through rod 61 striking blade 13² against the sheet, which is met at a point between the ends of blades 13¹. Blade 13² now carries the sheet between folding members 56 in a fold in an action that discharges the sheet endwise from blades 13¹ before they are again advanced, and thereafter in a continuation of the movement brings it into the predetermined position for the following fold, where again it is held in place by frictional detaining devices, the follow-through blade in this case being withdrawn after positioning the sheet. The further revolution of shaft 39 now causes strap 55 to slacken and strap 54 to begin rotating its drum and through it shaft 26, thereby through arm 79 and rod 77 operating blade 13³ against the sheet. According as the sheet was originally entered in one lateral position or another at the feed-board it will now have the position shown in Fig. 15 or that shown in Fig. 16, but blade 13³ will strike it at a point determined by the throw of blade 13². Blade 13³ strikes the sheet between revolvable folding members 68 and 69, spring-pressed to engage it from either side, which thereupon roll upon the two faces of the blade in a flattening or sealing action over the several folds, the blade rotating them. In this embodiment they are rotated by friction, a more positive rotation not being required for the uses in mind, but the invention is not limited to any particular type of drive for them, and it will be noted that the similar revolvable folding members 15 and 16 have a toothed drive. The continuation of the folding stroke of blade 13³ carries the sheet between the adjacent sheet-support 93 and the sheets already stacked, as shown in Fig. 18. At times a third fold will not be required. In such cases the operator will make a turnbuckle adjustment giving blade 13³ a throw past the third folding line just sufficient to cause the sheet to be engaged, or else alternatively just short of the width of the sheet, so as to cause either its leading edge or its rearward edge to be engaged by blade 13³ and carried upon revolvable folding member 68 or else 69, so as to be advanced between the two. In the latter case he will also retract folding member 68 by lifting the ends of springs 86 from pins 84 to pins 85. In such case the blade cooperates with member 69 to advance the sheet, and it also acts to make a path for the sheet behind the sheets already stacked. Springs 95 prevent its displacement by the withdrawal of the blade. The friction of spring 96, or of the sheets already stacked, acts to prevent displacement of other sheets by the blade. The same result in some cases will follow if member 68 is not retracted, but the positioning of the sheet by blade 13³ is more critical. It will be seen that by advancing blade 13³ far enough the sheet can be discharged thereby without being engaged by blade 13³ at all.

Fig. 14 shows the mechanism just described with an additional follow-through folding blade added for making a fourth fold. The blade is indicated at 13⁴; it is carried upon arms 57⁴ attached upon shaft 58⁴ journaled between said arms in cross-frames 7, and its construction is essentially that of blade 13³ previously described. Curved plate 93 in this embodiment is replaced by sheet-supports 93^m having similar stacking

functions and also acting frictionally like friction members 56, 70 and 71 to assist in holding the positioned sheet in place, spring 96 cooperating therewith. The blade is operated by arm 100 attached upon the rear end of shaft 58⁴, said arm bearing a downstanding pin 101 on which is journaled one end of rod 102, the other end of said rod being removably journaled upon pin 103 on arm 104 attached upon the rear end of shaft 46 previously described. The third-stage blade 13³ in this embodiment is given a variable throw by means of slot 105 in the nearer of arms 57³ along which pin 76 is adjustably positioned. The construction will be more fully explained later in connection with Fig. 22. A curved plate 93⁴ is attached with stacking board 92⁴ upon cross-frames 7 to serve as a sheet-support. The construction is such that when rod 102 is slipped from pin 103, blade 13⁴ can be left in the stacking position shown in Fig. 14, if use is not required of it. In such case the folded sheet will be stacked by blade 13³ upon stacking board 92. Pressure rolls of any usual or approved type are indicated at 68^m and 69^m to cooperate with blade 13⁴ in a folding and fold-flattening action. A soft spring 96⁴ repeats the functions of spring 96 in such use, and the stacking action is like that already described.

The embodiment of the invention shown in Figs. 20, 21 and 22 differs in construction from that before described. Use is made in all three folding stages of a follow-through blade, but instead of employing pressure rolls for the first fold it makes this fold without them, and instead of employing a revolvable carrier, namely an endless chain, for the first-stage blade, it employs a carrier, likewise flexible, having a reciprocating action. This embodiment varies the stopping position of the second-stage blade not by shifting its arc of throw as a whole, but by varying the angle of throw. The earlier embodiment gave the several blades an intermittent folding action alternated with a period of rest. In this embodiment the period of rest is replaced by a period of idle movement, partly absorbed by suitable devices. This embodiment provides a special adaptation for first-stage use of the sheet-entering provision shown in the third stage of the earlier one, for entering sheets not requiring a first-stage fold. The embodiment is constructed entirely without using toothed gear-wheels or chains and sprockets.

It is described as follows: The first-stage follow-through blade, indicated at 13^m, is attached at either end upon carriers 10^m, preferably straps, the forward ends of which are attached upon the periphery of wheels 106, these being attached upon shaft 107 journaled at the ends in side-frames 6^m. Shaft 107 bears also attached upon it between said wheels a drum or pulley 108, on which is attached one end of belt or strap 109, the other end of said strap being attached upon drum-segment 110, attached upon the lower end of shaft 58^m. An arm 111 is likewise attached near the lower end of said shaft; it bears on it a pin 112 on which is journaled one end of rod 113, the other end of which is journaled on pin 114 on arm 115 attached upon the lower end of shaft 116 journaled in cross-frames 7^m. The upper end of shaft 116 has attached upon it an elbow-lever 117, one arm of which is slotted at 105 and supplied with indices 66^m on a suitable plate. The slot provides a seat for an adjustable connecting device, consisting of a flattened and headed bolt 118, bushing 119 and hand-nut 120, 75

the bushing acting as the shoulder of a pin heretofore indicated at 103, upon which is journaled in this situation one end of rod 121. A pointer on flattened bolt 118 is indicated at 67m; it co-operates with indices 66m to indicate the point to which a second-stage follow-through blade 13m² will be carried, a position on the slot of bushing 119 giving said blade a greater angle of throw or a less, according as it is nearer or further from shaft 116 its axis. Rod 121 is journaled at its other end upon pin 122 on wheel 123, attached upon the upper end of drive shaft 125 journaled in cross-frames 7m. Straps 10m, attached at their forward end upon wheels 106, are attached at the other upon roll 126, journaled on fixed axle 127, which is attached at either end upon side frames 6m. A spring 128 coiled about said axle is attached at one end thereto and at the other upon the roll in such manner as to act rotatingly upon the roll against the pull of straps 10m. Straps 10m are bent engagingly over a revoluble folding member 69m, whose axle 130 is journaled in side frames 6m, in such manner as to rotate it. Intermediate tapes or cords 131 are attached at one end to blade 13m¹ and at the other to roll 126. These also pass over folding member 69m when extended; their purpose is to supply a sheet-advancing means for a sheet not required to be folded by blade 13m¹. They constitute in effect an extension of the blade, and cooperate with revoluble folding member 69m in advancing an unfolded sheet much as blade 13³ cooperates with revoluble member 69 in the earlier embodiment. A stationary folding member 68m, recessed at said tapes, is underhung so as to be permanently retracted from the line of feed, instead of being optionally retractible like member 68 in Fig. 9, the construction being such, like the earlier one, that the blade will enter a sheet unfolded from a considerable range of positions and with great certainty. The underhung position of member 68m does not affect its folding function. It is not necessary that member 68m be non-revolvable, nor that it be mounted out of contact with folding member 69m, nor that the entered sheet be advanced by member 69m through the cooperation of tapes. Like the sheet-advancing pressure rolls 15 and 16 of Figs. 1 and 9, member 69m is rotated by the carrier of the first-stage blade. Friction-guards 37 in this embodiment are multiple; as before they assist in holding the positioned sheet in place after the completion of the positioning stroke. Since blade 13m¹ does not advance beyond this point, but is withdrawn backwardly, the end-stops against which a non-folded sheet is positioned after passing from the control of member 69m need not be retractible. The present end-stops are indicated at 32m. They are attached upon paper tables 31 on either side of their central division.

The second-stage follow-through blade in this embodiment is indicated at 13m². Its construction is essentially that of blade 13², and it is carried upon similar arms 57² attached upon shaft 58. It is operated through arm-extension 59, pin 60 thereon, rod 61m journaled on said pin, and pin 62 on an arm of elbow-lever 117. Instead of curved friction-plates 71 and 72 to assist in holding the sheet positioned thereby in place, uncurved plates 71m and 72m are shown. Otherwise the associated structure is similar to that of the earlier embodiment.

The third follow-through blade is indicated at 13³, being similar in construction and use to

that described before. It is carried on similar arms 57³, but these in this case are attached upon shaft 58m³ previously described, by which it is operated. The cooperating folding members 68 and 69 are also essentially those of the earlier embodiment, but the retracting devices for member 68 are slightly different in form. Member 68 in this case is journaled like member 69 upon a non-rotating axle, indicated at 80m, which is attached upon springs 86m, the latter being attached at the other end upon shaft 83m journaled in cross-frames 7m. A resilient lever 82m attached upon said shaft is engaged at will upon projection 84m or projection 85m on one of said frames; if upon the former, it acts as indicated in Fig. 22 to press member 68 toward member 69, but if upon the latter, it acts to retract member 68 into inoperative position.

The embodiment is operated as follows: The operator through hand-nut 120 and bolt 118 brings pointer 67m to the required position opposite indices 66m, the sheet is positioned on the feed-board, and drive shaft 125 is rotated, thereby through pin 122 and rod 121 causing elbow-level 117 to rock shaft 116 through a greater or smaller angle, and through arm 115, rod 113 and arm 111 on shaft 58m³ causing segment 110 to rotate drum 108, thereby rotating wheels 106 on the same shaft. Said wheels act pullingly upon straps 10m, bringing blade 13m¹ against the sheet, which is carried thereby between revoluble member 69m and stationary member 56m in a fold. The advance of the blade is continued until the folded sheet is positioned for the next fold. A continued rotation of shaft 125 now causes segment 110 to slacken strap 109, thereby permitting roll 126 to take up straps 10m and withdraw blade 13m¹ into its original position. A further rotation of shaft 125 acts through pins 60 and 62, rod 61m and arm extension 59 to swing blade 13m² downward upon the sheet, which is struck in a fold between folding members 56m as in the earlier embodiment and position for the following fold. The remaining action is the same as that of the earlier embodiment previously described. It will be noted that the adjusting provision varying the angle of rotation of shaft 116, and therefore the angle of throw of blade 13m², varies also the throw of blades 13m¹ and 13³, but in the latter cases the throw is varied at the idle end and not at the end of the work-stroke. It will be noted further that I employ rock-shaft 116 as an intermediary between drive shaft 125 and the several blades, instead of operating them directly from the drive shaft, in order to make use of the dead centers available in this construction to reduce their ultimate idle movement. The construction is not essential. The advantage is that the mechanism is constructed more compactly so, and the blades strike the folds at a slower speed.

It will be noted also that the indicating devices shown herein are claimed more broadly in my pending application for patent filed December 19, 1931, Serial No. 582,142. In the said application the sheet is shown as folded over separable blades, and the width between the folding lines established thereby is directly indicated by movable devices at the feed-board, so that symbolic indices are not required. In the present application the width between given folding lines is shown as varied by devices that vary the action of a positioning means, in this case a follow-through blade, and an indicating mechanism is

associated with said devices to indicate that width through index symbols.

Having thus clearly explained the nature and objects of my invention and the manner of applying the same, I claim as new and desire to secure by Letters Patent,—

1. In a folding machine, in combination: means adapted to make a fold in a cut sheet of paper, including folding members and a follow-through blade, said blade adapted to strike a sheet between said members in a fold and thereafter through an engagement inside the fold to advance it into a plurality of operative positions variably affecting its next-stage folding; and next-stage folding means adapted to fold said sheet when in one of said operative positions.

2. In a folding machine, in combination: folding means, including a follow-through blade adapted to fold a sheet and position it for next-stage folding and a next-stage blade operable in a path intersecting the path of the same; and means interconnected with one of said blades for varying the distance between the intersecting point of said paths and the point to which said first-named blade advances its fold, thereby enabling the operator at will to vary the distance between the folds produced by the respective blades on a given sheet.

3. In a folding machine, in combination: folding means embracing a plurality of stages, including a follow-through blade adapted to cooperate in folding a sheet and thereafter through engagement inside the fold to advance it out of reach of the next-stage folding means, for inter-stage discharging purposes; and means adapted to control said discharging action.

4. In a folding machine, in combination: folding means, including a follow-through blade adapted to strike a sheet into a fold and thereafter through engagement inside the fold to advance it into next-stage engaging position for edgewise forwarding; and means engaging said sheet for such forwarding, whereby the sheet may be forwarded past the next-stage folding mechanism without sustaining a folding action therefrom.

5. In a folding machine, in combination: revolvable folding members, a follow-through blade adapted to strike a sheet in a fold between said members and thereafter through a continuation of its stroke to advance it into a predetermined position beyond said members, and means cooperating therewith effective in a folding operation upon cut sheets of paper.

6. In a folding machine, in combination: revolvable folding members; a follow-through blade adapted to strike a sheet in a fold between said members and thereafter through a continuation of its stroke to advance it into a predetermined position beyond said members; and toothed means connecting said blade and said revolvable members to co-act while advancing said sheet between them.

7. In a folding machine, in combination: a revolvable member; a blade adapted to carry a sheet without folding it into engagement with said member in a follow-through sheet-advancing action toward its next operative position; and means cooperating therewith to position said sheet for the next operation thereon.

8. In a folding machine, in combination: sheet-advancing devices, including a roll and a follow-through blade having a yielding engagement therewith, said blade adapted to carry a sheet against the roll and to advance it thereafter, all

without folding it, thereby switching it past one folding stage without sustaining a fold, and without being discharged from its operative path; and folding means cooperating therewith to fold cut sheets of paper.

9. In a folding machine, in combination: folding means, including devices yieldingly pressed toward each other, adapted to flatten a fold; and a follow-through blade adapted to enter a sheet between said devices and to advance the same thereafter completely through them in an action able to flatten the folds thereon.

10. In a folding machine, in combination: means adapted to establish a fold in a sheet; folding rolls adjacent to the subsequent path of said sheet; and a follow-through blade adapted to carry such sheet between said rolls and thereafter in a follow-through action in which said blade sustains a progressive engagement therewith to cooperate with the rolls in flattening the folds on said sheet.

11. In a folding machine, in combination: means adapted to make a fold in a cut sheet of paper, including a follow-through blade adapted to advance a sheet into a plurality of operative positions variably affecting its next-stage folding; means adapted to make a next-stage fold in said sheet; and means adapted to vary the advance of said blade, thereby changing the relative position of said next-stage fold with respect to said earlier fold.

12. In a folding machine, in combination: folding means, including a follow-through blade adapted to press the sheet into a fold and thereafter to advance it beyond its next engaging position into a position out of reach of further folding means, for discharging purposes; and means adapted to change the advance of said blade, so as to fold the sheet further or discharge it, at will.

13. In a folding machine, in combination: folding means, including a follow-through blade adapted to advance a sheet either into position for next-stage folding or for edgewise forwarding unfolded; and means adapted to vary the advance of said blade, thereby enabling the operator either to give his sheet a next-stage fold or to forward it unfolded past the next-stage folding mechanism, at will.

14. In a folding machine, in combination: a reciprocating blade adapted to advance a folded sheet into its next operative position through an edgewise engagement therewith inside the fold; and means adapted to vary the point at which said blade ends its positioning stroke, for the purpose of varying the position on the sheet of the next fold.

15. In a folding machine, in combination: folding members; a follow-through blade operable to strike a sheet into a fold between said members and thereafter to advance the same into position to receive a fold parallel with the first; and means connected to vary the operation of said follow-through blade for the purpose of varying the separation of said folds on the sheet.

16. In a folding machine, in combination: a reciprocating follow-through blade adapted to advance a folded sheet into positions variably affecting its next-stage folding; means adapted to vary the advance of said blade so as to vary such sheet-positions and therefore the next-stage folding operation; and indicating devices connected to said means, said devices adapted to indicate the next-stage position to which a given adjustment will advance the sheet, thereby enabling the operator to make any desired adjustment in advance and with speed and certainty.

17. In a folding machine, in combination: folding members; a follow-through blade operable to strike a sheet in a fold between said members and to advance it thereafter into positions to receive a fold parallel to the first; means adapted to vary the advance of said blade, so as to vary the separation of said folds; and indicating means connected to said means for indicating the adjustment thereof, for the purpose of enabling the operator to make advance adjustments for a desired fold separation.
18. In a folding machine, in combination: folding devices, including a sheet-advancing follow-through blade mounted upon an axle parallel to its working edge, and a later-acting blade having a path crossing the path of said first-named blade; means adapted to vary the advance of said first-named blade past the intersecting point of said paths; and indicating devices relatively movable one to the other, adapted to indicate the adjustment of said means with respect to affecting the advance of said blade, thereby enabling the operator to make quick and sure adjustments in advance for his desired folds.
19. In a folding machine, in combination: folding members; a follow-through blade operable to strike a sheet in a fold between said members and adapted to advance it thereafter into a position to receive a next-stage fold parallel to said fold; means adapted to give said blade a working movement; and means adapted to shift the extent of throw of said blade, thereby varying the position to which it advances the sheet and therefore the separation of said folds on the sheet, said means including a connecting rod of adjustable length.
20. In a folding machine, in combination: folding devices, including a sheet-advancing follow-through blade adapted to advance a sheet into positions variably affecting its next-stage folding; an axle for said blade parallel to the working edge thereof; devices adapted to vibrate said axle so as to give said blade an arc-like working movement; and inter-connected devices adapted to shift the arc of throw of said blade so as to end its work-throw at varying points, said devices including turnbuckle devices.
21. In a folding machine, in combination: folding devices, including a sheet-advancing follow-through blade adapted to advance a sheet into positions variably affecting its next-stage folding; an axle for said blade parallel with the edge thereof; devices adapted to vibrate said axle; and inter-connected devices adapted to vary the angle of vibration of the axle, thereby varying the extent of advance of said blade and said sheet, and therefore the next-stage folding of the sheet, said devices including a crank-pin adjustable on a slotted lever.
22. In a folding machine, in combination: folding means, including a sheet-advancing follow-through blade adapted to advance a sheet into positions variably affecting its next-stage folding; an axle for said blade parallel to the edge thereof; means adapted to vibrate said axle; means including a crank-pin on a slotted lever inter-connected to vary the angle of vibration of said axle, thereby varying the extent of advance of said blade and said sheet, and therefore the next-stage folding of the sheet; and relatively movable indicators connected thereto so as to enable the operator to make advance adjustments thereof for a desired folding action.
23. In a folding machine, in combination: folding devices, including a follow-through blade adapted to strike a sheet into a fold and thereafter to advance the same in an arc-like path into stacking position, an axle for said blade parallel to the working edge thereof, and means connected to vibrate said axle; and a supporting member positioned between said axle and said stacking position, said member adapted to support a sheet deposited against it in such manner that upon the withdrawal of the blade the natural straightening of the sheet will tend to rock or straighten its rearward edge away from its original path, thereby facilitating the edgewise entrance behind it of the blade with the next sheet to be stacked.
24. In a folding machine, in combination: folding devices, including a follow-through blade adapted to strike a sheet into a fold and thereafter to advance the same in an arc-like path into stacking position, an axle for said blade parallel to the working edge thereof, and means connected to vibrate said axle; and a curved supporting member positioned between said stacking position and said axle, said curved member adapted to support a sheet deposited against it in such manner that upon the withdrawal of the blade the natural straightening of the sheet will tend to rock or straighten its rearward edge away from its original path, thereby facilitating the edgewise entrance behind it of the blade with the next sheet to be stacked.
25. In a folding machine, in combination: folding devices, including an axle-borne follow-through blade adapted to strike a sheet into a fold and thereafter to advance the same edgewise in an arc-like path into stacking position, said blade mounted with its working edge parallel to its axis, and constructed curved to conform to its arc of movement, thereby facilitating its withdrawal; a supporting member positioned between said stacking position and the axle of said blade; and a yielding member adapted to press against the sheet advanced by said blade in a manner permitting its forward movement but resisting its backward movement with the withdrawing blade.
26. In a folding machine, in combination, revolvable members adapted to advance a sheet, a follow-through blade adapted to enter a sheet between said members, and carrier devices supporting and operating said blade, means connecting the carrier devices to act rotatively upon said revolvable members.
27. In a folding machine, in combination: folding members; a divided follow-through blade cooperating therewith to fold a sheet, said blade constructed in two parts disposed end to end with a space between, to permit the discharge of the sheet over the interior ends thereof; and carrier devices supporting the parts of said blade from either side.
28. In a folding machine, in combination: folding devices, including a follow-through blade adapted to position a sheet; flexible carriers supporting the blade; and actuating means for said carriers, said means including a crank connected to advance them a predetermined distance, thereby bringing the sheet into a required operative position.
29. In a folding machine, in combination: folding devices, including a follow-through blade adapted to fold and advance a sheet; chain carriers supporting the same; and actuating means for said carriers, including toothed sprocket wheels and a crank drive adapted to give said

wheels a predetermined rotation, thereby advancing the sheet into a predetermined position for next-stage folding.

5 30. In a folding machine, in combination: folding devices, including a follow-through blade adapted to position a sheet; strap-like carriers supporting the same; and actuating means for said carriers, including a crank interconnected to advance them a predetermined distance and
10 thereby bring the sheet into a predetermined position for next-stage folding.

31. In a folding machine, in combination: folding means, including a follow-through blade adapted to advance a sheet; and flexible reciprocating carriers therefor having a work-stroke established by an interconnected crank and an idle stroke actuated through revolvable retracting devices from a spring, said work-stroke through said blade acting to advance the sheet into predetermined position. 5

WILLIAM JONATHAN NEIDIG. 10