Aug. 21, 1923. 1,465,440

G. S. HOUSTON

PAPER FOLDING MACHINE

Filed March 24, 1921 5 Sheets-Sheet 1

FIG. 1

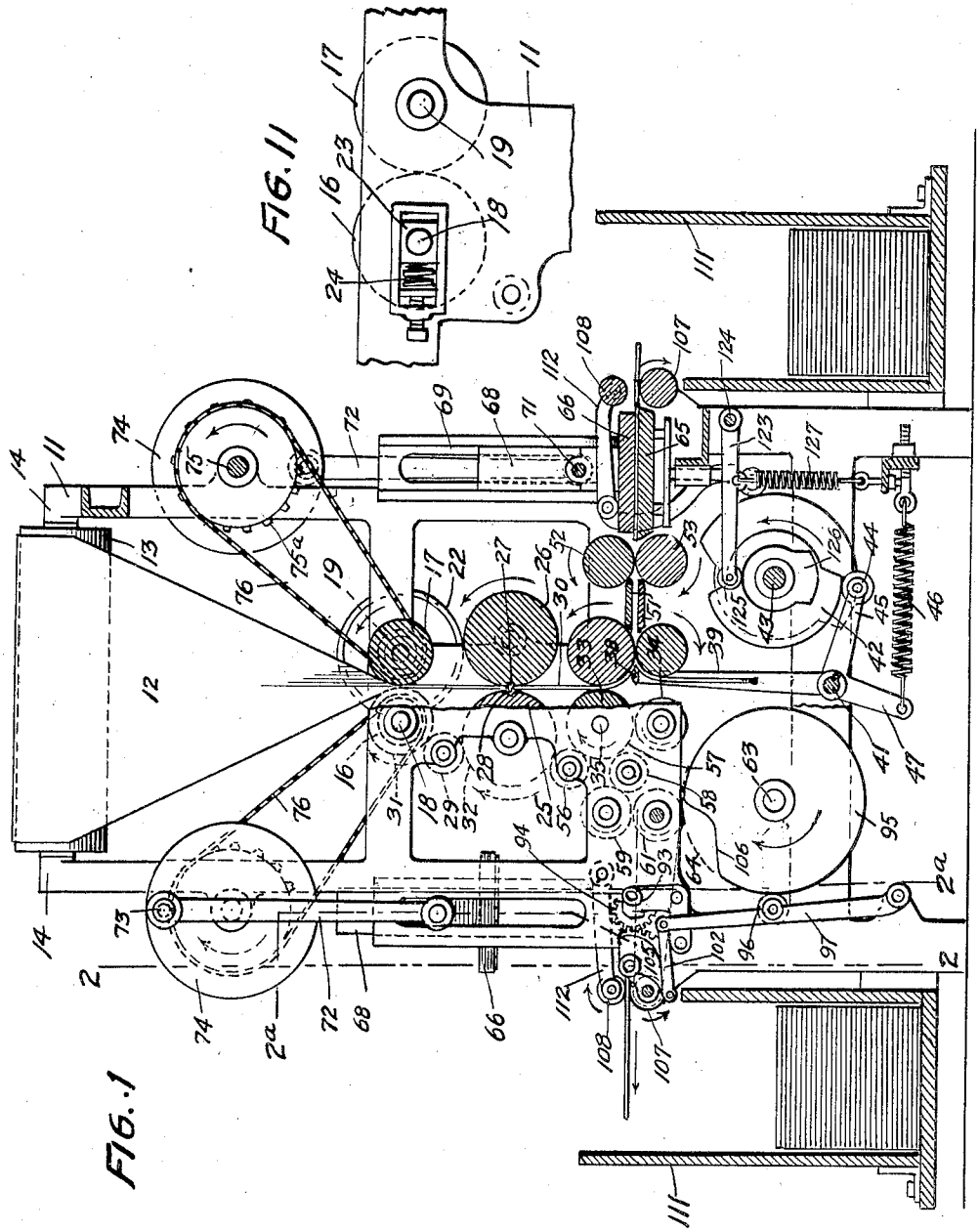


FIG. 11



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BY Paul & Paul

HIS ATTORNEYS

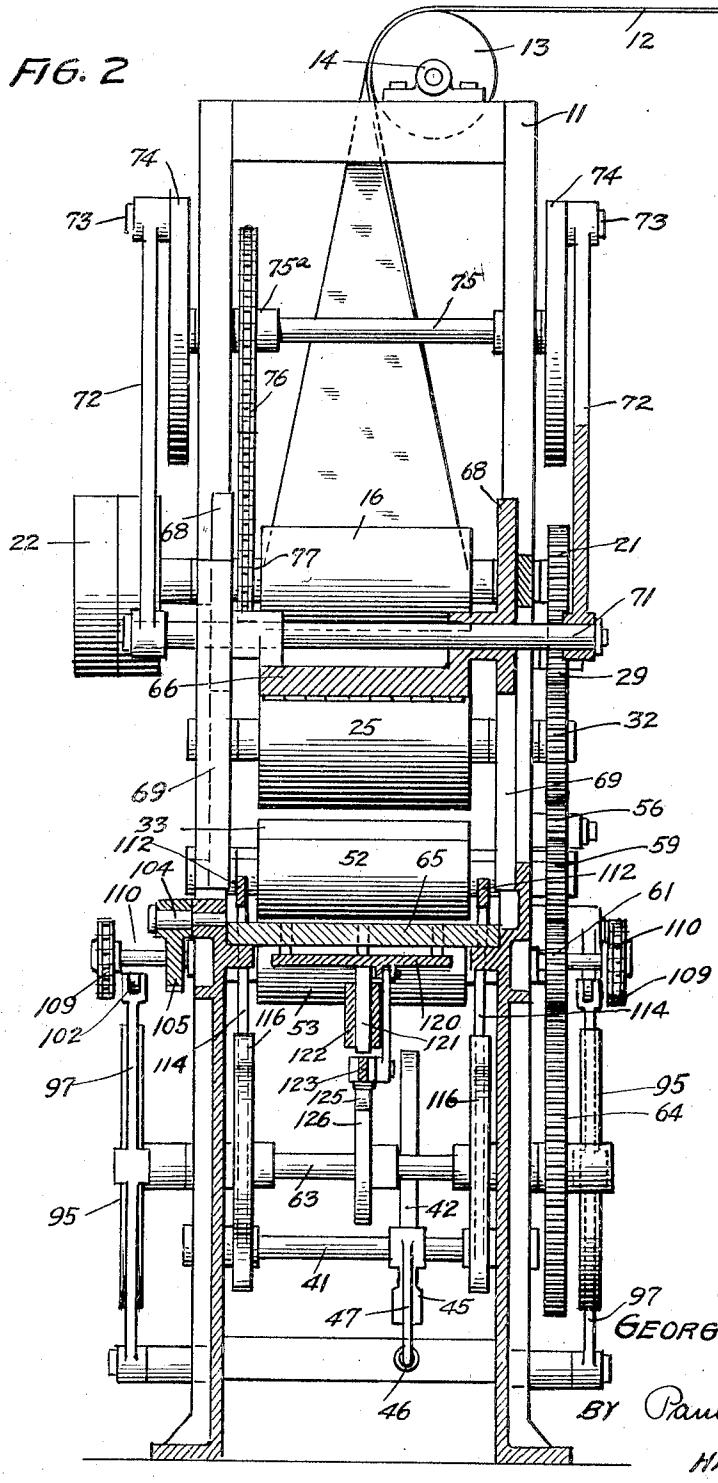
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PAPER FOLDING MACHINE

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FIG. 2




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G. S. HOUSTON

PAPER FOLDING MACHINE

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FIG. 3

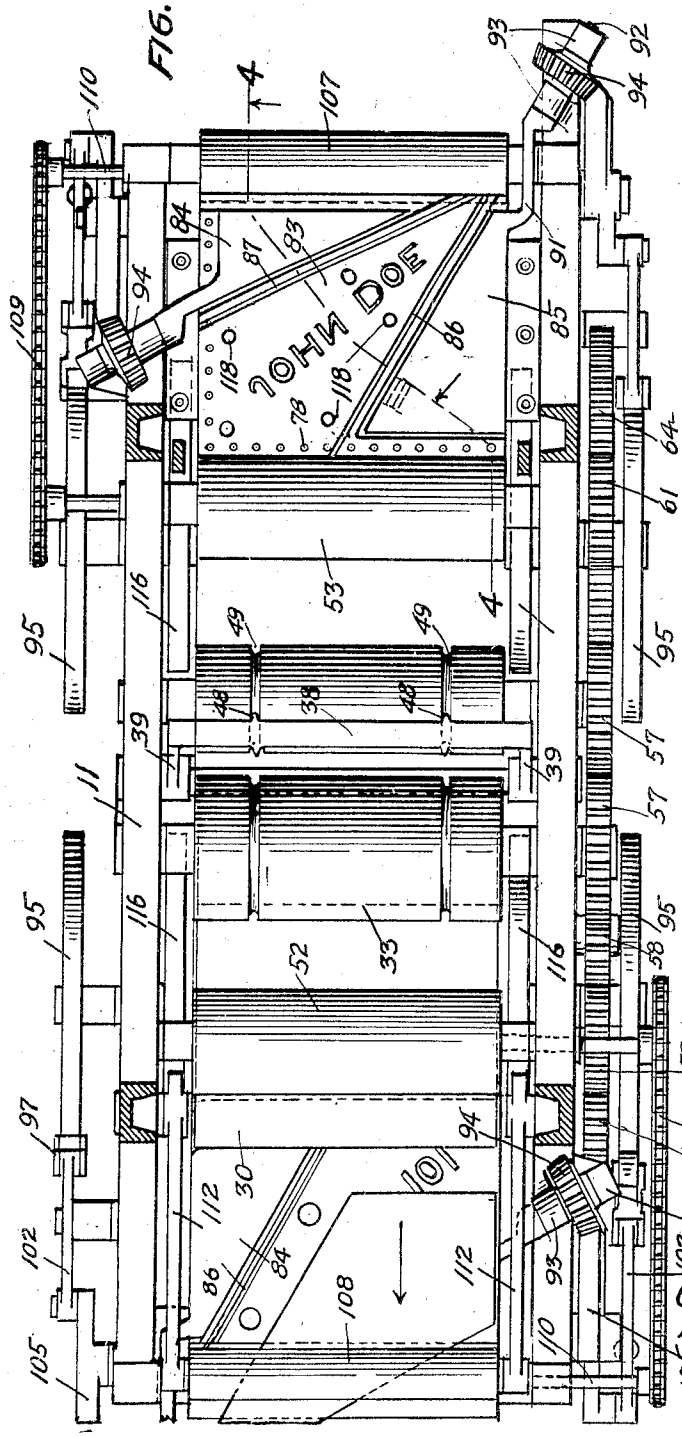
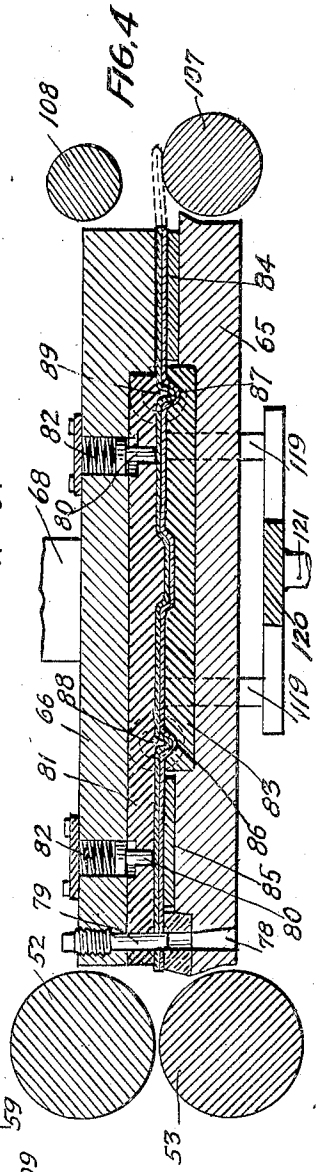



FIG. 4



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PAPER FOLDING MACHINE

Filed March 24, 1921 5 Sheets-Sheet 4

FIG. 5

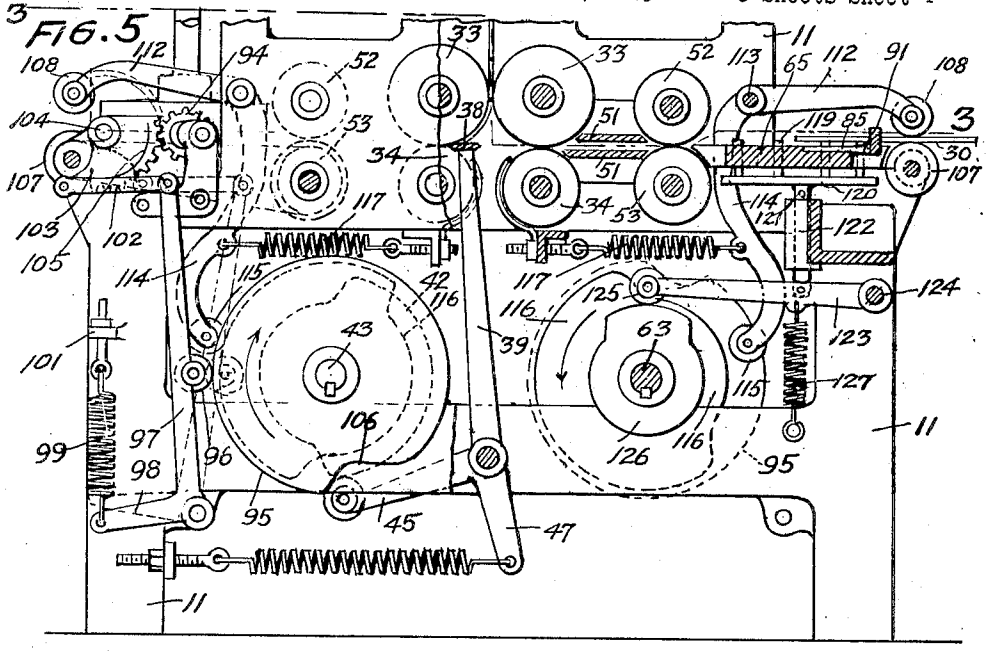



FIG. 6

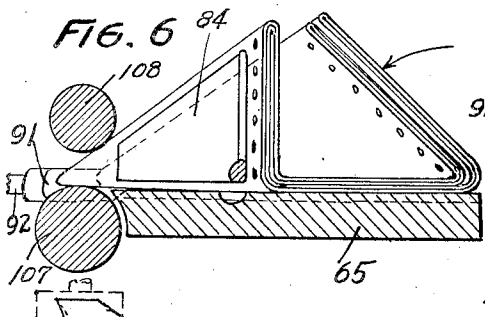



FIG. 7

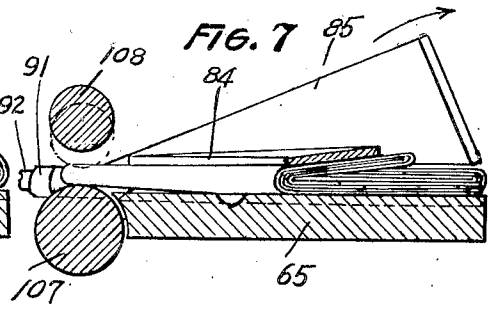
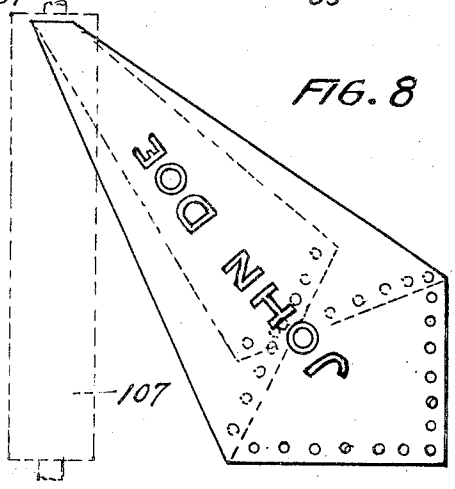



FIG. 8




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PAPER FOLDING MACHINE

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FIG. 9

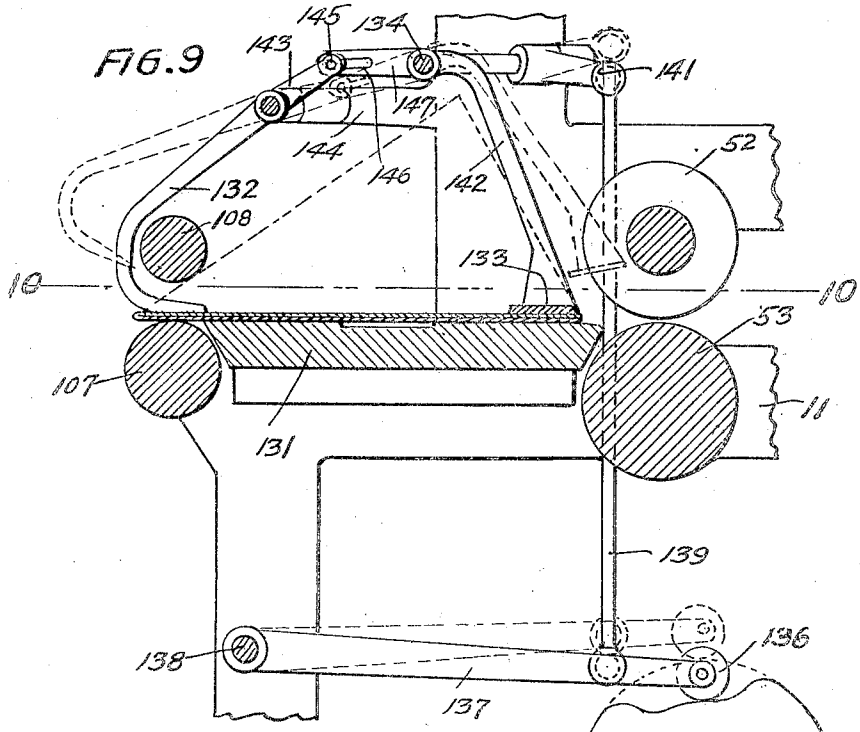
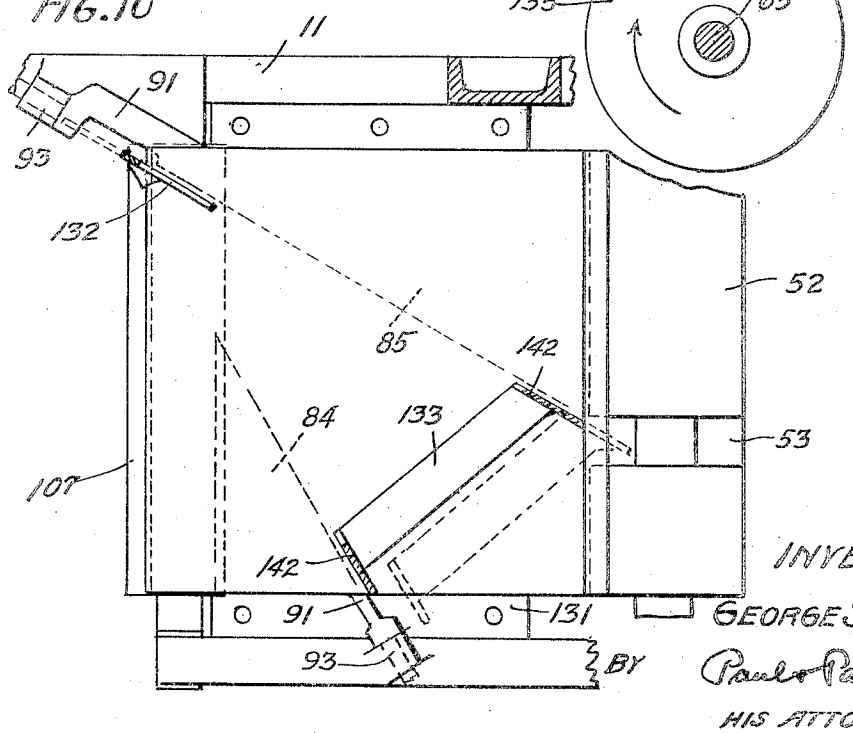



FIG. 10




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Patented Aug. 21, 1923. 1,465,440

# UNITED STATES PATENT OFFICE.

GEORGE S. HOUSTON, OF MINNEAPOLIS, MINNESOTA.

## PAPER-FOLDING MACHINE.

Application filed March 24, 1921. Serial No. 455,041.

*To all whom it may concern:*

Be it known that I, GEORGE S. HOUSTON, a citizen of the United States, and resident of Minneapolis, in the county of Hennepin and State of Minnesota, have invented certain new and useful Improvements in Paper-Folding Machines, of which the following is a specification.

This invention relates to improvements in machines adapted to fold sheets of paper. The selected embodiment of the invention here disclosed is particularly adapted to fold paper napkins of the type in general use in restaurants, hotels, public dining rooms, etc. Provision in this novel machine is also made for the embossing of advertising matter or other indicia on the napkin during the folding operation.

The object of this invention, therefore, is to provide an improved paper folding machine.

Other objects of the invention will more fully appear from the following description and the accompanying drawings, and will be pointed out in the annexed claims.

In the accompanying drawings there has been disclosed a structure designed to carry out the objects of the invention, but it is to be understood that the invention is not confined to the exact features shown, as various changes may be made within the scope of the claims which follow.

In the drawings:

Figure 1 is a view through the machine, part in elevation and part in section, the frame of the right side of the machine being broken away;

Figure 2 is a composite view through the machine, the left side being a sectional view on the line 2—2 of Figure 1, while the right side is a sectional view on the line $2^a$—$2^a$ of Figure 1;

Figure 3 is a section on the line 3—3 of Figure 5;

Figure 4 is a section on the line 4—4 of Figure 3;

Figure 5 is a view in vertical section through the lower portion of the machine similar to Figure 1, but of the opposite side of the machine;

Figure 6 is a detail showing a step in the folding operation;

Figure 7 is a detail showing a step in the folding operation subsequent to that shown in Figure 6;

Figure 8 is a detail view showing the folded embossed napkin and its position with relation to the discharge roll.

Figure 9 is a sectional view of a modification of the folding mechanism;

Figure 10 is a sectional view of the modification on the line 10—10 of Figure 9; and

Figure 11 is an enlarged detail view of a bearing box of the upper feed roll.

The selected embodiment of the novel machine here disclosed includes a supporting frame 11 by which are supported the various parts of the machine, such as the paper-feeding roll; the device for initially providing a half-fold in the paper; the cutting means to sever the fed paper into folded sheets; the quarter-folding means, preferably in duplicate; the co-operable dies for embossing the quarter-folded sheets; and the means for diagonally folding the embossed sheets.

This novel machine is adapted to receive paper from the usual commercial paper roll and to cut the paper into sheets of the desired napkin size and to fold the napkin size sheets into a diagonally folded napkin ready for use. The usual form of paper roll is not necessary to be shown but the paper 12 is led therefrom to the idler guide roll 13 rotatably mounted in bearings 14 provided at the top of the frame 11 and on opposed sides thereof. From the guide roll 13, the paper is drawn over a folding plate of a type common in the newspaper folding art, by which means the paper is folded into one-half its width. The half-folded paper is drawn between the power-driven feed rolls 16 and 17 by means of which the paper both is drawn from the original roll of paper over the guide roll and is folded as received from the folding plate. The rolls 16 and 17 are fast on their respective shafts 18 and 19 rotatably borne by the frame 11. The shafts and their respective rolls are driven at the same rate of speed and in opposite directions (see arrows, Fig. 1) through intermeshing gears 21 fast on each shaft. The shaft 19, to which the feed roll 17 is fixed, bears a pulley 22 fast thereon. The pulley is belt-driven from a suitable source of power, not shown. The shaft 18 of the feed roll 16 is

preferably borne in bearing boxes 23 whereby the roll 16 is tensionably pressed toward its complementary roll 17 by means of the springs 24.

The cutting rolls 25 and 26 are positioned below the feed rolls and are rotated at the same speed and in opposite directions (see arrows, Fig. 1). The cutting roll 26 bears a knife blade 27 which projects from, and extends longitudinally of, the periphery of the roll 26. A longitudinal recess 28 is provided in the periphery of the complementary roll 25 and synchronous rotation of the two cutting rolls 25 and 26 causes the blade 27 to register with its complementary recess 28 each revolution whereby the paper fed between the two rolls is cut into successive sheets 30. Each of the cutting rolls is gear-driven from its adjacent superposed feed roll, as for example, by means of an idler 29 meshing with a gear 31 fast on a feed roll shaft and with a gear 32 fast on a cutting roll shaft. This gearing is diagrammatically represented in Figure 1 and in full lines on the right in Figure 2. The timing of the cutting operation with relation to the rate of feed of the paper is such that the paper is cut into folded sheets of the desired dimension. At this stage of the operation of the machine, the paper from the usual paper roll has been half-folded and thereafter cut into half-folded sheets.

As noted above, the remaining operations are preferably effected in duplicate in order to increase speed of production of the machine, although it is to be understood that such operations may be singly effected if desired. For sake of brevity and clarity but one set of the similar parts need be described while the corresponding parts of the other set will bear the same numerals.

The quarter-folding is accomplished by means of superposed pairs of co-operable folding rolls 33 and 34. There are two such pairs. One pair is arranged upon each side of the plane of descending travel of the paper and severed sheets, and below a cutting roll. The shaft 35 of one of the upper rolls 33 is preferably borne in bearing boxes carried in the frame 11 and similar to the bearing boxes 23 of the upper feeding rolls, so that one of the upper rolls 33 may be similarly tensionably pressed toward the opposed upper roll by means of springs whereby continuous travel of the cut sheets is maintained.

Means are provided to direct the middle portion of each successive sheet between the quarter-folding rolls. In this embodiment of the invention, the sheets are alternately directed to the opposite quarter-folding rolls. The reciprocal feed-bar 38 functions to direct the middle portions of successive sheets alternately to these opposed pairs of folding rolls. The bar 38 is of a length substantially equal to the longitudinal dimension of the folding rolls 33 and 34 and is provided with opposed tapered edges in order to engage a sheet and to start the quarter-fold in presenting the sheet to these rolls. The bar 38 is carried at its ends by means of arms 39 secured at their lower ends to a rock-shaft 41 carried by the frame. Movement of the rock-shaft 41 is governed by a cam 42 fast on the shaft 43 through the cam-follower 44 carried by the bell crank lever 45 secured to the rock-shaft 41. The cam shaft 43 is driven in timed relation to the cutting rolls by a gear-train hereinafter described. The cam 42 is shaped to provide a quick movement to the feed-bar 38 in directing the middle portion of a sheet to a pair of quarter-folding rolls. In the position of these parts shown in Figure 1, the cam-follower has just entered upon the high portion of the cam 42 and the feed-bar has presented a sheet to the folding rolls 33 and 34. As is obvious from the shape of the cam 42, the feed-bar remains in such position until the follower has traversed the high portion of the cam and descends to the lower portion thereof. At such time, the sheet 30 will have been fed between the rolls 33 and 34 and another sheet will have descended on the other side or behind the feed-bar. When the follower reaches the lower portion of the cam, the tension spring 46 (under increased tension during the high traverse of the follower) is permitted to exert its pull to turn the rock-shaft 41 thereby to cause the feed-bar 38 to thrust the next sheet between the opposite quarter-folding rolls. The timed relation of paper or sheet travel to rotation of the cam 42 and feed-bar reciprocation is such that the feed-bar directs the middle portion of the sheet to the rolls. The spring 46 is affixed at one end to the frame 11 and at its other end to the arm 47 of the bell crank lever 45.

While the feed-bar 38 may be employed with straight unbroken edges, it is preferred to form marginal projections thereon adapted to enter between the rolls 33 and 34. (See Fig. 3). As here shown, each tapered edge of the feed-bar is provided with two teeth 48 which, when the feed-bar is in sheet-presenting position, are received within annular grooves 49 formed in the periphery of the two rolls. By means of these teeth, the leading edge of the sheet is substantially carried in advance of the major portion of the feed-bar and is directed and guided farther between the two rolls than is possible without the use of the teeth.

The rolls 33 and 34 receive the half-folded sheet from the feed-bar and, by their rotation in opposite directions, draw the sheet so that an additional or quarter-fold is given to the sheet by its passage therebetween.

Adjacent the outer faces of these co-operable rolls are positioned two opposed and longitudinally extending plates 51 between which is received the quarter-folded sheet from the rolls 33 and 34. The edges of the plates adjacent the rolls are beveled and are positioned closely adjacent the peripheries of the two rolls so that they may have a stripping function in the event of a folded sheet tending to follow one of the rolls. The plates 51 are secured at their extremities to the frame 11. The plates are adapted to deliver the quarter-folded sheet between the co-operable drawing rolls 52 and 53 from whence the sheet is directed to the diagonal folding machine. The rolls 52 and 53 are also actuated indirectly by the power shaft 19 of the feed roll 17. A simple mode of actuating the several rolls and cam-shafts in timed relation is diagrammatically represented in Figure 1. As above noted, the shaft 19 is driven from a suitable source of power by the pulley 22 while the shaft 18 of the roll 16 is driven from the shaft 19 by intermeshing gears 21. The gear 31 of the shaft 18, meshing with the idler 29 rotatably borne by the frame, transmits power to the gear 32 of the shaft of the cutting roll 26. As heretofore described, the gear 32 fast on the cutting roll shaft drives, through the idler 56, a gear 57 on the upper quarter-folding roll 33; while an idler 58 drives the gear 59 on the upper drawing roll shaft from the gear 57. The gear 61 on the shaft of the lower drawing roll meshes directly with the gear 59 on the shaft of the upper drawing roll 53. These gear trains are duplicated for each vertical set of rolls so that opposed co-operable working rolls are driven at the same rates of speed and in opposite directions, while the cam-shafts 43 and 63 are each driven by the intermeshing of the relatively large gears 64, fast on each cam-shaft, with the gears 61 of the lower drawing rolls 53 on each side of the machine.

The mechanism for diagonally folding the sheets receives the successive sheets from the complementary drawing rolls 52 and 53 at either side of the machine. This mechanism preferably includes the apparatus whereby folding creases are made in the sheets, various indicia, a decorative border, etc., are impressed upon, or punched out of, the sheets, prior to the diagonal folding; but, by employment of the apparatus shown in Figures 9 and 10, the pre-creasing, impressing and bordering operations are omitted and the diagonal folding directly accomplished without such prior operations.

The construction and operation of the preferred mechanism which pre-creases, impresses and borders the sheets will first be described. These three operations are effected by way of a fixed die and a movable die. These mechanisms, as previously noted, are duplicated at each side of the machine and but one need be described. The fixed die 65 is suitably secured to the frame 11 of the machine. This die, as is indicated in plan in Figure 3, is substantially oblong. The movable die 66 is similarly shaped and is carried by the cross-heads 68 mounted slidably to reciprocate in the slotted guides 69 provided on opposite sides of the frame 11. The cross-head 68 are carried on a pin 71 having pivotal connections through connecting rods 72 with crank pins 73 of discs 74 mounted upon a transverse shaft 75, rotatably borne by the frame 11 and having a sprocket $75^a$ fast thereon driven by the chain 76 from the sprocket 77 fast on the adjacent driven feed roll whereby the movable die is actuated in timed relation to the other parts of the machine. The quarter-folded sheets are successively discharged upon the upper face of each fixed die and each such sheet may have a decorative border. As here disclosed, this bordering is effected by means of the series of holes 78 through the fixed die adjacent two of its edges, as shown in Figure 3. Such punch-holes are provided along two edges only, as the sheet is quarter-folded and the single punching adjacent two edges will effect a complete punched-out border on the four marginal portions of the unfolded sheet. Punching teeth 79 are provided on the under face of the movable die and enter the punch-holes 78 at each descent of the movable die whereby marginal holes are cut in the folded sheet. These punch teeth are preferably received in threaded engagement through the hard metal die plate 81 fitted in a recess in the under face of the movable die 66. Means are provided to prevent the punched sheet from sticking to the movable die plate and to this end a plurality of headed releasing pins 80 outwardly project from the under face of the die plate. These pins 80 are normally projected by means of compression springs 82 seated in spring chambers formed in the movable die 66.

Indicia, such as advertisements, etc., may be impressed or embossed upon the sheets by these dies. By way of example, there is here indicated the name "John Doe," the constituent letters of which are recessed in the die plate 83 of hard metal secured to the fixed die, while the complementary embossing letters project beyond the surface of the movable die plate 81. These complementary embossing means are preferably diagonally disposed on the two die plates so that the embossed indicia will be clearly visible upon the completed diagonally folded sheets.

The punching and indicia-impressing parts may be omitted from this preferred diagonally folding mechanism, and the complementary dies employed only to ac-

complish their important and valuable pre-creasing operation. This pre-creasing is a desirable step preparatory to the diagonal folding operation and will be described in connection with the pivotal wings which effect the diagonal folding. The upper face of the fixed die 65 is suitably recessed not only to receive the die plate 83 but also to receive the two folding wings 84 and 85. Each wing is mounted normally to rest upon the recessed upper face of the fixed die and to have its turning axis closely adjacent and substantially parallel to the diagonal creasing grooves 86 and 87 formed near the edge of the die plate 83. The positioned sheet is pressed into these creasing grooves upon descent of the movable die by the diagonal ribs 88 and 89 integrally projecting from the die plate 81. Diagonal creases are thus provided in each sheet along which the sheet may easily be folded by the two pivoted wings. In the form here shown, each wing resembles a right-angled triangle. The turning axis of each wing substantially corresponds to its hypotenuse which also is the diagonal wing edge mentioned above as being adjacent to each creasing groove. These wings are mounted to turn on their axes inwardly or toward each other in timed relation after the ascent of the movable die. Each wing is provided with an offset extension 91 which outwardly terminates in a reduced portion forming a shaft 92 rotatably borne by the bracket 93. The axis of each shaft 92 is in alinement with the turning axis of its wing. A bevel gear 94 is fast on each shaft 92 and is adapted to be oscillated to turn the wing to accomplish its folding function.

The timed oscillation of each wing of the duplicate diagonal folding mechanisms is effected indirectly from the driven cam-shafts 43 and 63. A suitable means of effecting this timed actuation of these bevel gears 94 is shown on the left of Figure 1 and in enlarged detail on the left of Figure 5. These means are similar and reference may particularly be had to Figure 5 in describing this actuation. A cam 95 is keyed to the cam-shaft 43 and a roller 96 borne by the lever 97 functions as the cam follower. This lever is pivotally mounted on the frame 11 adjacent its lower end and is provided with an integral arm 98 terminally secured to an end of a tension spring 99 adjustably mounted on the lug 101 of the frame. This spring tends to hold the lever 97 to the right of its position in Figure 5 and thus also to hold the roller 96 against its cam. The upper end of the lever 97 has pivoted thereto one end of the link 102, the other end of which is pivotally connected to the curved arm 103. This arm at its upper end is pivotally mounted on the frame stud 104 and has a preferably integral beveled gear sector 105 in mesh with the bevel gear 94. When the roller 96 is tensionably pressed into the depression 106 of the rotatory cam 95, the sector is upwardly thrust to actuate the wing gear 94 and, when the roller again rises to the high portion of the cam, the sector is downwardly thrust and the wing in question is returned to normal inoperative position. The wings 84 and 85 of each complementary pair are also operated in timed relation to each other as is indicated in the diagrammatic views, Figures 6 and 7. As therein shown, the wing 84 precedes the wing 85 in its folding movement while the reverse is obviously true of the releasing movement. If desired, a plurality of hinges 100 may be secured to the fixed die and to the wings to aid in guiding the wings about their turning axes.

Discharge of the diagonally folded sheet at each side of the machine is effected by means of the cooperable delivery rolls 107 and 108. The roll 107 is rotatably mounted on the machine frame closely adjacent the outer edge of the fixed die which is preferably arcuately curved as is indicated in Figure 4. This lower delivery roll 107 is positively driven by means of the chain 109 running over sprockets on the shaft 110 of the delivery roll and the shaft of the lower drawing roll 53. The upper delivery roll 108 is an idler normally held in raised inoperative position, but adapted to be downwardly moved, in timed relation to the completion of the diagonal folding, to press the completed sheet against the surface of the driven delivery roll 107 to cause movement of the folded sheet from the surface of the fixed die and thereafter to drop into the adjacent receptacle 111 provided on either side of the machine frame. The idler delivery roll 108 is mounted to rotate in the ends of the opposed levers 112 each of which is pivoted on studs 113 to the machine frame and is formed with an integral curved arm 114 terminally bearing a roller 115 which functions as a cam follower for the cams 116 keyed on the cam-shaft 63 at one side of the machine or to the cam-shaft 43 at the other side. A tension spring 117 adjustably secured to the frame functions to hold the cam follower tensionably against its cam.

Releasing apparatus to prevent the sticking of the sheet to the fixed die after the creasing or impressing or bordering operations is preferably provided. This is effectively accomplished by the provision of a plurality of apertures 118 in the fixed die through which apertures may project pins 119 carried upon a base 120 mounted upon a post 121 reciprocally slidable in the bearing 122 on the frame. The post 121 is operatively connected to the lever 123 pivoted to the frame at one end 124 and carry-

ing a roller 125 at its other end. The roller 125 is adapted to follow the cam 126 against which it is tensionably held by the spring 127 secured both to the lever 123 and to the frame 11. The cams 126 for operating these releasing pins for each of the two fixed dies are keyed respectively to the driven cam-shafts 43 and 63 and hence the pins are actuable in timed relation to the other parts of the machine.

The modified forms disclosed in Figures 9 and 10 may be employed, as heretofore noted, in place of the die mechanism whereby the pre-creasing step, as well as the impressing or embossing and bordering steps, are omitted and the quarter folded sheet is diagonally folded by the complementary wings immediately upon delivery by the drawings rolls. A base 131 is employed in place of the fixed die and is similarly countersunk or recessed to receive the similar complementary folding wings 84 and 85. Two members are employed to hold the sheet during the diagonal folding by the complementary wings. These may be referred to as the fingers 132 and the feet 133. The finger is adapted, during the folding operation to engage and hold the leading or narrow tapered portion of the sheet while the foot is adapted to function similarly with relation to the trailing or relatively broader portion of the folded sheet. A rock-shaft 134 is suitably borne by the machine frame 11 and is adapted to be oscillated as, for example, by the cam-shaft 63 through a cam 135 keyed thereto and followed by a roller 136 terminally borne by a lever 137 pivoted on the stud 138 of the machine frame. A rod 139 is pivotally mounted on the lever 137 and upwardly extending terminates in a pivotal connection with the rocker arm 141 keyed to the rock-shaft 134. The foot 133 is carried by the offset legs 142 keyed to the rock-shaft, while the finger 132 is integral with an arm 143 pivoted on the bracket 144 of the frame 11 and terminally carrying a pin 145 borne in a slot 146 in the arm 147 fixed to the rock-shaft 134. By means of the cam 135, the finger and foot are operable in timed relation to the folding wings so that the sheet is firmly held in position upon the folding base 131 during the folding operation and thereafter released by swinging of the finger and foot to the dotted line position shown in Figure 9.

I claim as my invention:

1. A paper-folding machine including cooperable folding rolls initially to fold a sheet of paper, means to direct the sheet of paper between said rolls, means to receive the folded sheet, and pivotally mounted members cooperable to fold the sheet diagonally, the pivotal axis of the members being substantially parallel to the desired diagonal fold.

2. A paper-folding machine including paper-feeding means, means to fold the fed paper, cutting means to sever the fed paper into sheets, co-operable folding rolls to fold the sheets, means successively to direct the severed sheets between the rolls, means to receive the folded sheets, and pivotally mounted members co-operable successively to fold the sheets diagonally.

3. A paper-folding machine including paper-feeding means, means to fold the fed paper, cutting means to sever the fed paper into folded sheets, opposed pairs of cooperable folding rolls to quarter-fold the sheets, means alternately to direct the quarter-folded sheets to the opposed rolls, means adjacent each pair of rolls to receive the folded sheets, and means adjacent each receiving means successively to fold the sheets diagonally.

4. A paper-folding machine including paper-feeding means, means to fold the fed paper, cutting means to sever the fed paper into folded sheets, opposed pairs of co-operable folding rolls to quarter-fold the sheets, means alternately to direct the quarter-folded sheets to the opposed rolls, means adjacent each pair of rolls to receive the folded sheets, and pivotally mounted members adjacent each receiving means co-operable successively to fold the sheets diagonally.

5. A paper-folding machine including folding means initially to fold a sheet of paper, means to add indicia to said sheet, and means thereafter diagonally to fold the sheet.

6. A paper-folding machine including folding means initially to fold a sheet of paper, means to impart diagonal creases thereto and to emboss indicia thereon, and means thereafter diagonally to fold the sheet along the creases.

7. A paper-folding machine including paper-feeding means, means to fold the fed paper, cutting means to sever the fed paper into folded sheets, opposed pairs of co-operable folding rolls to quarter-fold the sheets, means alternately to direct the quarter-folded sheets to the opposed rolls, co-operable means adjacent each pair of folding rolls to receive the folded sheets and diagonally to crease the same, and means thereafter to fold each sheet along said creases.

8. A paper-folding machine including folding means initially to fold a sheet of paper, means to receive the folded sheet, pivotally mounted members co-operable to fold the sheet diagonally, and a pivotal bearing for each member in alinement with and beyond the desired diagonal folded line.

9. A paper-folding machine including paper, means to receive the folded sheet, folding means initially to fold a sheet of pivotally mounted members co-operable to fold the sheet diagonally, and a bearing portion integral with each member, each bear-

ing portion projecting in alinement with and beyond the desired diagonal folding line.

10. A paper-folding machine including folding means initially to fold a sheet of paper, means to receive the folded sheet, pivotally mounted members co-operable to fold the sheet diagonally, a bearing portion for each member in alinement with and beyond the desired folding line, and offset means connecting each member with its alined bearing portion.

In witness whereof, I have hereunto set my hand this 22d day of March, 1921.

GEORGE S. HOUSTON.