S. WHEELER.

FOLDING DEVICE.

APPLICATION FILED NOV. 1, 1920.

1,436,302. Patented Nov. 21, 1922.

7 SHEETS—SHEET 1.

Fig. 2.

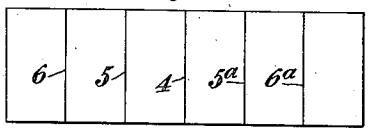


Fig. 1.

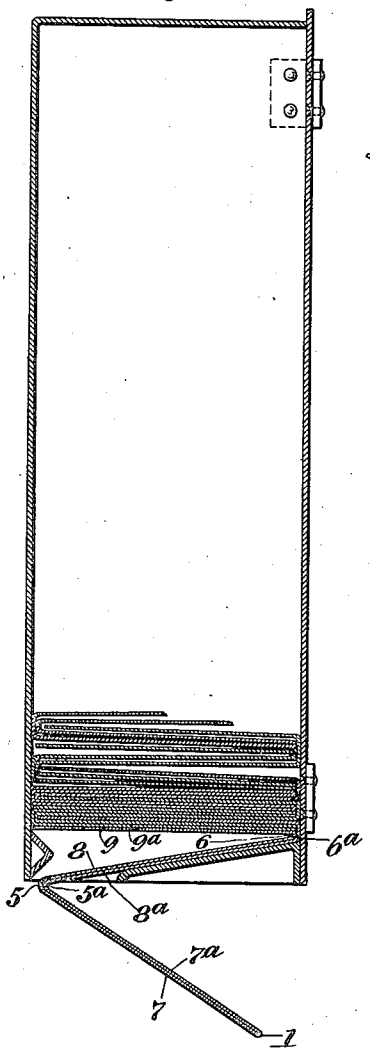


Fig. 3.

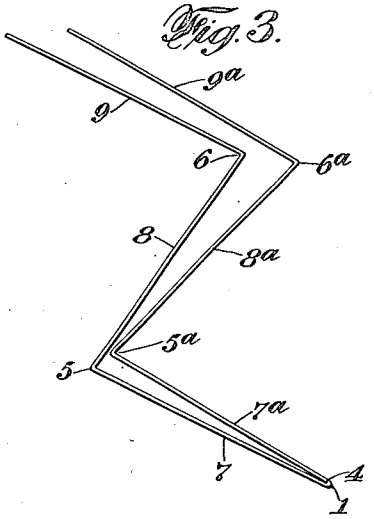


Fig. 4

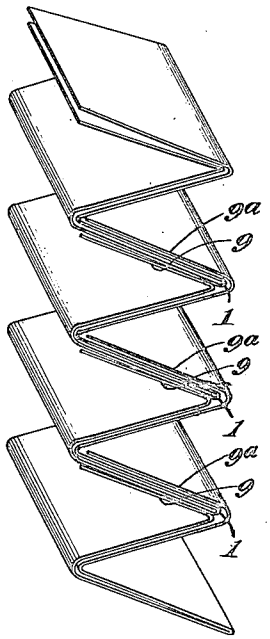
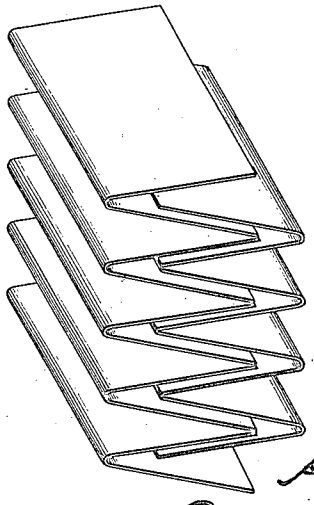


Fig. 5.



INVENTOR

Art Wheeler

BY

Pindle, Wright & Brown

ATTORNEYS

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7 SHEETS—SHEET 2.

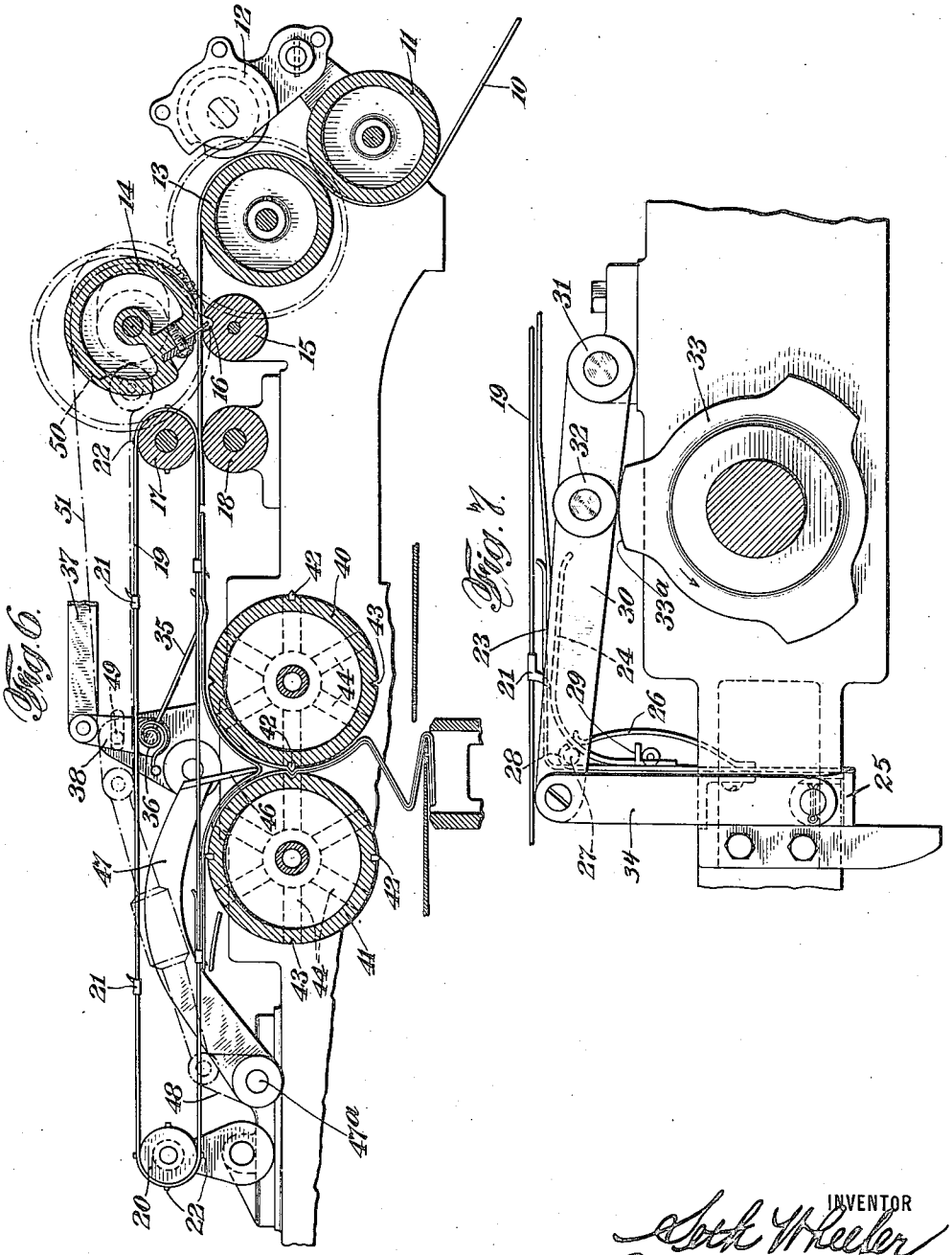


Fig. 6.

Fig. 7.

INVENTOR

Scott Wheeler

BY

Priddle Wright & Small

ATTORNEYS

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7 SHEETS—SHEET 3.

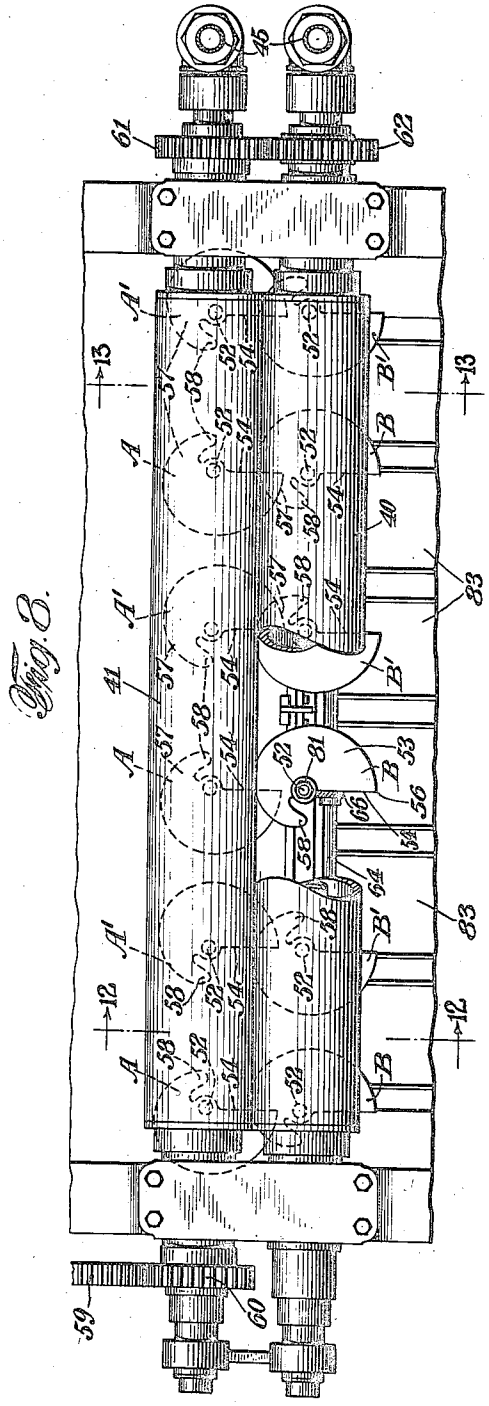


Fig. 8.

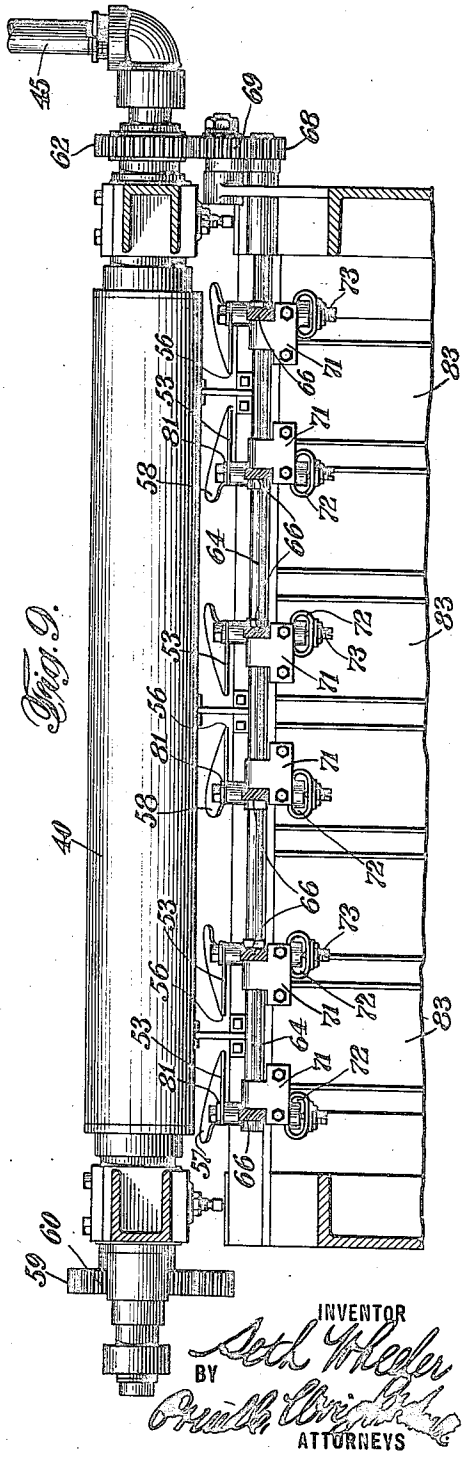


Fig. 9.

INVENTOR

BY

ATTORNEYS

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1,436,302. Patented Nov. 21, 1922.

7 SHEETS—SHEET 4.

Fig. 10.

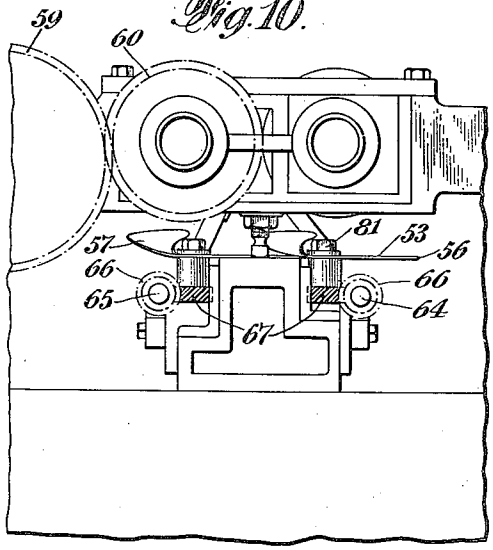


Fig. 11.

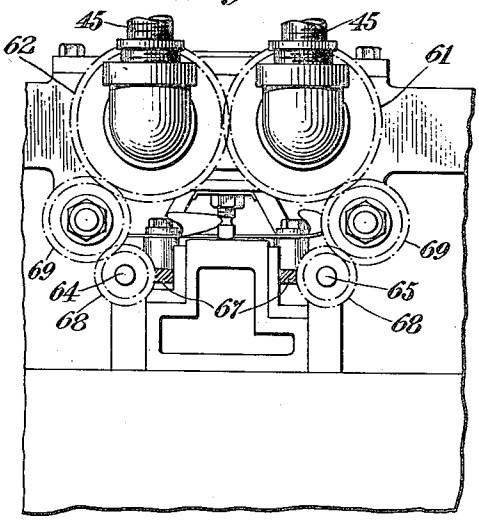


Fig. 12.

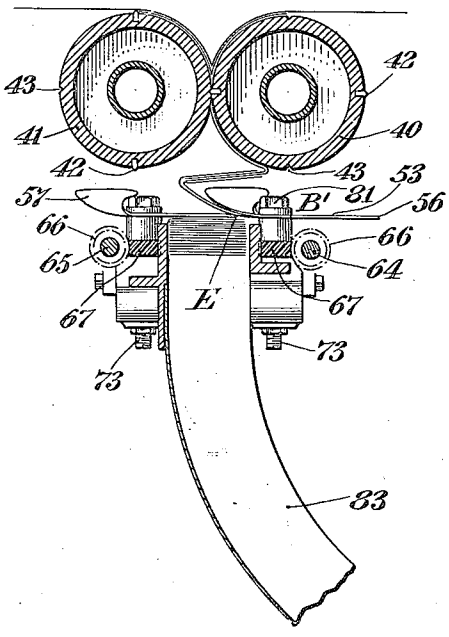
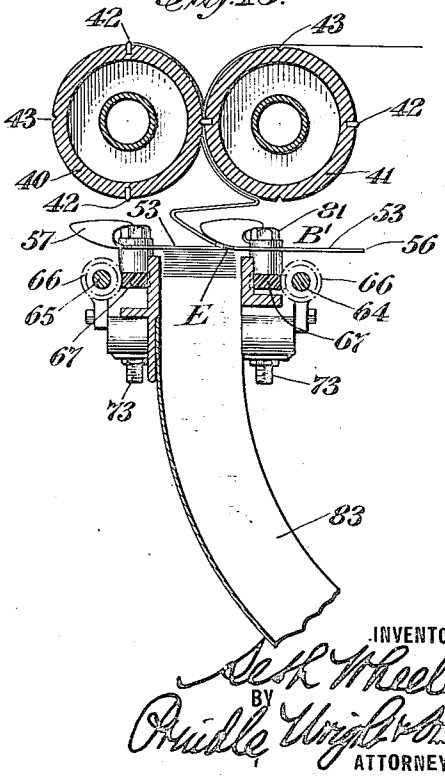


Fig. 13.



INVENTOR

Jesse Wheeler

BY

Riddle Wright & Small

ATTORNEYS

S. WHEELER.

FOLDING DEVICE.

APPLICATION FILED NOV. 1, 1920.

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7 SHEETS—SHEET 5.

Fig. 16.

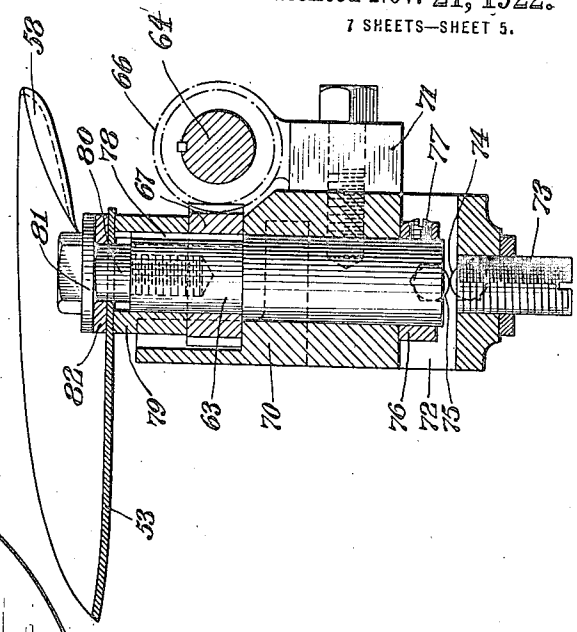


Fig. 14.

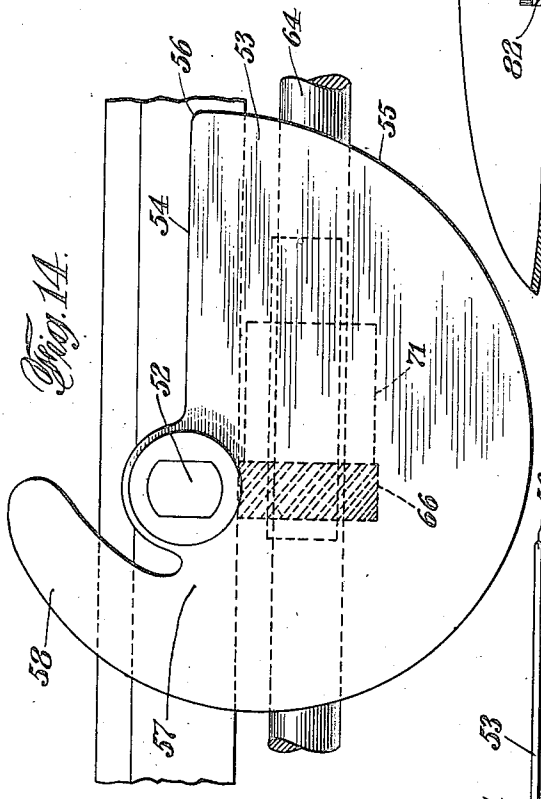
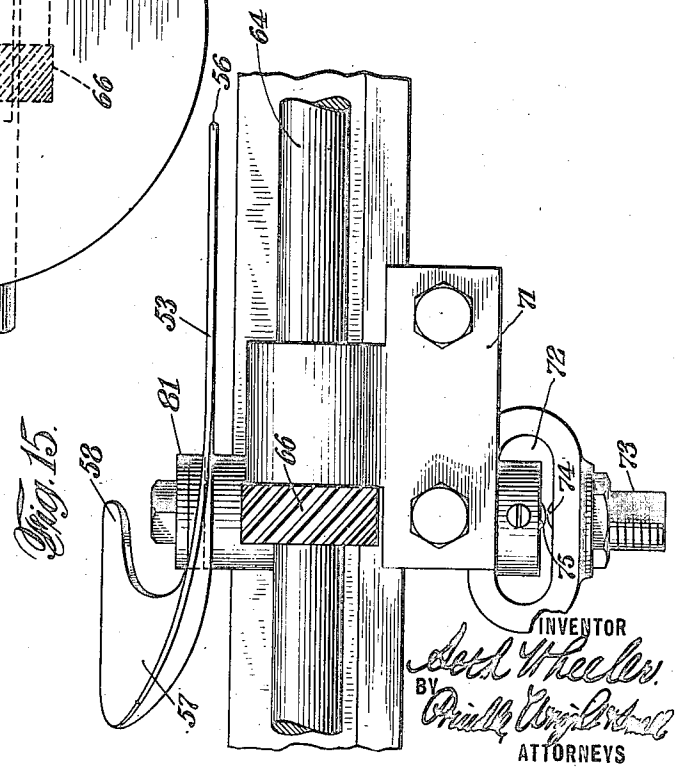


Fig. 15.



INVENTOR

Jack Wheeler.

BY

ATTORNEYS

S. WHEELER.

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APPLICATION FILED NOV. 1, 1920.

1,436,302.

Patented Nov. 21, 1922.

7 SHEETS—SHEET 6.

Fig. 18.

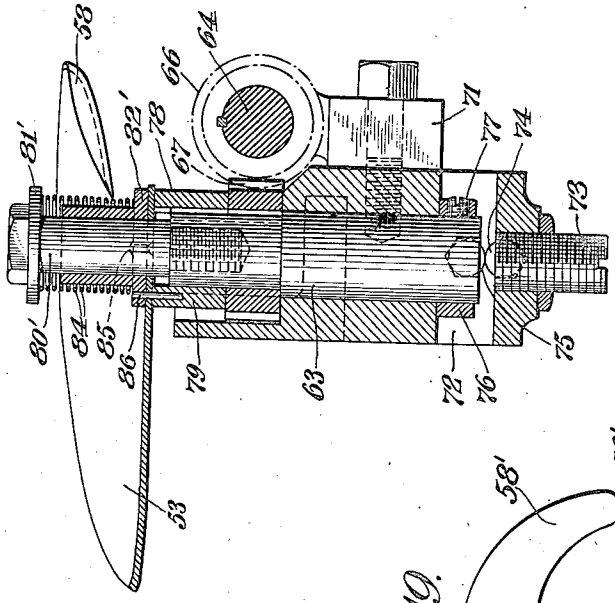


Fig. 20.

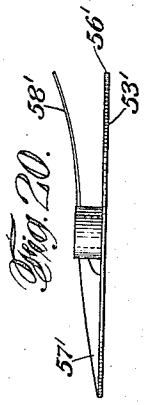


Fig. 19.

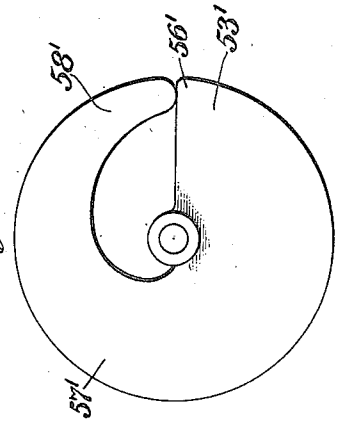
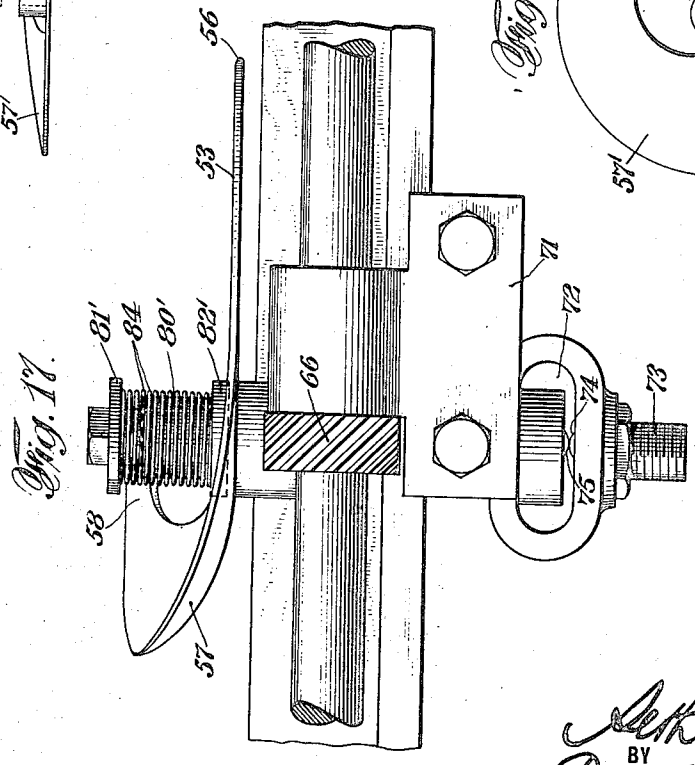


Fig. 17.



INVENTOR

Seth Wheeler

BY

Priddy Wright & Dorsey

ATTORNEYS

S. WHEELER.

FOLDING DEVICE.

APPLICATION FILED NOV. 1, 1920.

1,436,302.

Patented Nov. 21, 1922.

7 SHEETS—SHEET 7.

Fig. 21.

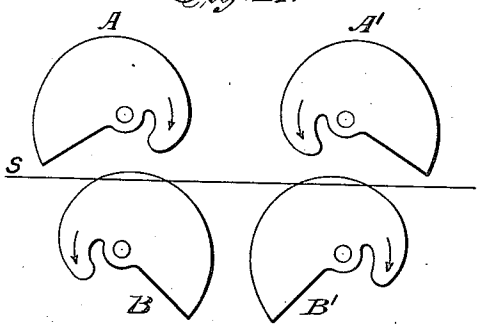


Fig. 22.

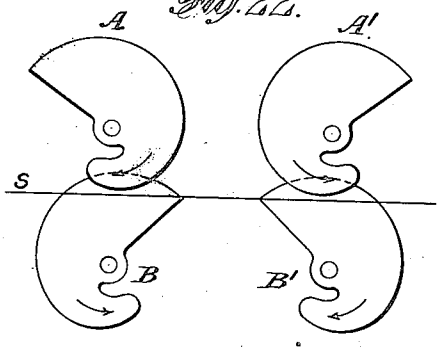


Fig. 23.

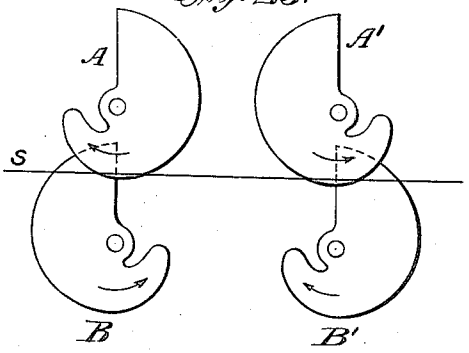


Fig. 24.

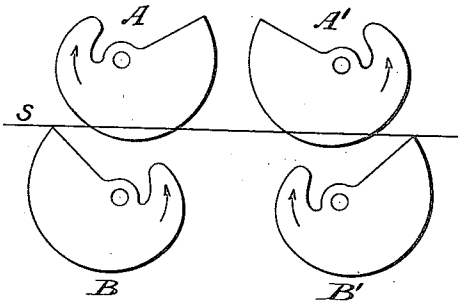
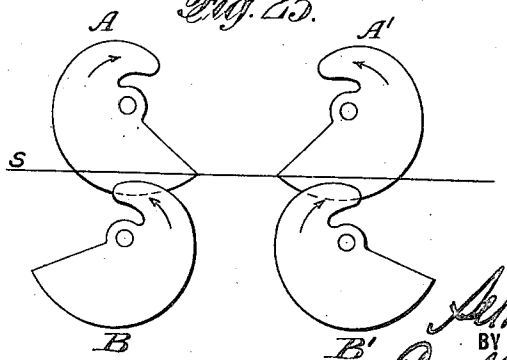


Fig. 25.



INVENTOR

Seth Wheeler

BY

Orville Wrightsell

ATTORNEYS

Patented Nov. 21, 1922. 1,436,302

UNITED STATES PATENT OFFICE.

SETH WHEELER, OF CASTLETON, NEW YORK.

FOLDING DEVICE.

Application filed November 1, 1920. Serial No. 421,000.

To all whom it may concern:

Be it known that I, SETH WHEELER, a citizen of the United States, residing at Castleton, in the county of Rensselaer and State of New York, have invented certain new and useful Improved Folding Devices, of which the following is a specification.

My invention relates to the art of forming packages of paper or other material, and the object of my invention has been to provide an improved folding device in a machine for forming such packages, and which folding device shall be of simple construction and capable of efficiently and rapidly forming the packages referred to, and when such packages are made up of a plurality of sheets of the material operated upon either singly or interfolded.

My invention is capable of embodiment in many different forms, and, as a folding device, is capable of use with many different forms of machines for preparing the material in the form of the plurality of sheets to be folded; and while, therefore, I shall illustrate the preferred embodiment thereof, my invention is not to be limited to the particular form shown, but my claims are to be broadly interpreted.

I have selected as an illustrative example of a machine for preparing the material in the form of a plurality of sheets to be folded, with which my improved folding device may be used, the machine disclosed and claimed in my prior application, Serial No. 220,759, filed March 6, 1918; and my improved folding device may also be stated to be an improvement upon the folding mechanism disclosed and also claimed in my aforesaid prior application, that folding mechanism not being here shown, and only so much of the machine of the aforesaid prior application being here shown as required to illustrate the operative combination of my present improved folding device therewith. I have also selected as an illustrative example of one type of the package which my present invention is designed to produce, one of the types of packages also illustrated in my aforesaid prior application.

In the drawings—

Figure 1 is a vertical, longitudinal, sectional view of a dispensing cabinet containing a package of paper, such as may be made by my invention;

Fig. 2 is a plan view of a blank comprising a single sheet of material prepared by the machine for the folding operation;

Fig. 3 is a side elevation of the blank of Fig. 2 folded, but not in compact collapsed condition;

Fig. 4 is a perspective view of an interfolded package such as made by the machine described herein from the blank of Fig. 2, the package being uncollapsed;

Fig. 5 is a perspective view of an interfolded but not collapsed package, in which the units are made up each of a blank sheet folded but once to form a single pair of leaves extending from a single central fold or crease instead of three pairs of leaves extending from three separate folds or creases as in Fig. 3;

Fig. 6 is a detailed sectional view of the machine illustrated in my aforesaid prior application, showing the principal operative parts in preparing the blank sheet for folding;

Fig. 7 is a detailed view of certain mechanism of the aforesaid machine for transferring the blank sheet to the creasing cylinders preparatory to their introduction to the folding device;

Fig. 8 is a plan view from above of that part of the aforesaid machine confined to the creasing cylinders and their mountings and accessory parts, and showing particularly in dotted outline a plan view of one form of my improved folding devices below the creasing cylinders, one of the cylinders being partly broken away to show one of the folding devices in full plan outline;

Fig. 9 is a front elevational view of the machine as shown in Fig. 8;

Fig. 10 is a left-end elevational view of the machine shown in Figs. 8 and 9;

Fig. 11 is a right-end elevational view of the machine as shown in Figs. 8 and 9;

Fig. 12 is a sectional view taken on the line 12—12 of Fig. 8, looking in the direction of the arrow;

Fig. 13 is a view taken on the line 13—13 of Fig. 8, looking in the direction of the

arrow, Figs 12 and 13 also showing a section through the chute for the folded packages not shown in the preceding figures;

Fig. 14 is an enlarged plan view of one of the folding devices and showing its driving parts in dotted outline;

Fig. 15 is a side elevational view of the folding device and its driving parts shown in Fig. 14 and on the same scale;

Fig. 16 is a sectional view of the folding device and its driving parts on the line 16—16 of Fig. 14, looking in the direction of the arrow, but with the folding blade rotated 180 degrees from the position shown in Fig. 14;

Fig. 17 is a side elevational view of a modified form of the folding device, and Fig. 18 is a sectional, elevational view of the same;

Fig. 19 is a plan view and Fig. 20 is a side elevational view, on a somewhat smaller scale than Figs. 17 and 18, of a modified form of folding device, adapted for use particularly in folding a highly-finished paper as distinguished from that used for towels;

Figs. 21 to 25, inclusive, are diagrammatic views in plan showing various positions of the folding devices in their operation.

Referring to the drawings, one form of package which it is one of the objects of the invention to produce, is one which—as shown in Figs. 3 and 4—is especially adapted to be delivered from a receptacle preventing access to its contents as a whole and permitting the user to obtain only one unit at a time,—such, for instance, as for the purpose of delivering towels or toilet-paper. I desire that such package shall always present the units with a doubled or double edge for the user to take hold of, so that the user is less likely to tear the unit in withdrawing it from the receptacle, when his hands are wet; that such doubled edge shall preferably always project in the same direction from the cabinet, and that the units shall be so engaged with each other that the withdrawal of the lowermost unit shall with certainty cause the doubled or double edge of the next lowermost unit to project from the cabinet, and so that the units shall consist of two sheets fastened together instead of two separate sheets, either of which might be dropped to the floor without the other, and shall permit the use of a receptacle having a slight depth horizontally relative to the sides of the sheets of which the unit is made.

Another form of package, which it is one of the objects of my invention to produce, is that shown in Fig. 5, in which the sheets are each folded but once and interfolded, as shown in Fig. 5, in such a manner that the fold of each sheet encompasses adjacent leaves of two other sheets.

In Fig. I have shown a vertical, sectional view of the metal receptacle or cabinet containing such a package of paper as is shown in Figs. 3 and 4, and so arranged that it can be locked to prevent access to all but the lowermost units of the package. The doubled edge 1 of the lowermost unit of the paper package is intended to project through a slot 2 in the bottom of the receptacle in position for the user to take hold of. The package is so made that the withdrawal of this unit shall cause the corresponding doubled edge of the next lowermost unit to project in the same manner so that the units of the package are brought within reach one after another, until the entire package is used up.

The blank from which this form of unit is made is shown in Fig. 2 and consists of a sheet 3 having, preferably, a central fold 4 and parallel folds 5, 5^a, 6 and 6^a on opposite sides of and parallel to the central fold 4. The blank is folded on the line 4, thus forming the doubled edge 1, and the folds 5 and 5^a are both made in one direction, and the folds 6 and 6^a are made in the opposite direction. The blank thus consists of the folded edge 1, connecting leaves 7 and 7^a, intermediate leaves 8 and 8^a, and what may be termed "free" leaves 9 and 9^a.

The units are preferably interlocked—as shown in Fig. 4—to form a stack, pile or package, by locating the doubled edge 1 of each unit between the free leaves or terminals 9 and 9^a of the next lowermost unit.

A package having the units of the form shown in Fig. 4 is inserted in the case shown in Fig. 1 with the doubled edge 1 of the lowermost unit projecting through the slot, the cabinet being fastened to the wall so that this doubled edge projects away from the wall. When the user wishes a unit, he engages the doubled edge and pulls downward. This not only releases the lowermost unit, but draws the doubled edge of the unit above it through the slot so that it projects forward, as did the doubled edge just engaged by the user.

The principal operating parts for preparing the blank sheets and delivering them to the delivering device, of the machine of my aforesaid prior application here selected as one type of machine in which my present invention may be embodied, are shown in Figs. 6 and 7. As there shown, a web 10 from a roll of paper is lead under a roll 11 and between dividers 12 and bed roll 13. The web of paper is preferably wide enough to make a series of units side by side, and the dividers 12 are for the purpose of dividing the web on longitudinal lines between the proposed blanks or units.

After having been slitted longitudinally by the dividers, the web 10 passes between a cutter cylinder 14, and a mashing roll 15, which latter operates after the manner of a chopping block with a knife 16 on the

cutting cylinder to sever the web in lengths of the proposed units.

The forward end of the web, before the cutting action thereon, passes between rollers 17 and 18. A series of belts or tapes 19 passes over the upper roller 17 in grooves in the roller, the other ends of the tapes or belts passing over rollers 20. These belts or tapes are provided with hooks 21 which project in a forward direction when on the lower lap on the belts. Grooves or recesses are formed in the lower roller 18 to permit the hooks to pass between the rollers. The web of paper in passing between the rollers 17 and 18 is consequently engaged by the hooks 21, the said hooks being so spaced upon the tapes and timed by engagement of pins 22 on the upper rollers engaging with eyelets in the tapes, that they take hold of the web near its forward end and also in the back portion of the unit severed or to be severed, the unit thus being suspended on the underside of the tapes. The tapes are fed forwardly continuously.

The severed unit is carried forward on the hooks or tapes until its forward end stops between the upper and lower paper grippers 23 and 24, respectively (Fig. 7). The upper gripper 23 is pivotally mounted on a vertically movable carrier 25, and the lower gripper 24 is hinged to the said carrier. A spring 26 bears against the curved underportion of the lower gripper, and normally tends to hold said gripper pressed against the underside of the upper gripper. A pin 27 lies on the upper side of the curved portion of the lower gripper, there being one pin for each two adjacent pair of grippers, the pin having collars thereon to engage with the side of the grippers and prevent lateral displacement of the pins. A hook 28 is secured to a fixed part of the frame between the pairs of grippers, and a shoulder 29 is likewise secured to the said fixed part at some distance below the hook. The carrier 25 is raised and lowered by the action of a lever 30 fulcrumed at 31 on the frame, the lever carrying a roller 32 that rests upon a cam 33. A link 34 is pivoted to the lever and supports the carrier 25, the arrangement being duplicated at both ends of the carrier 25.

When the grippers are being raised to their highest position, the pin 27 is engaged by the hook 28, and the said pin, being prevented from rising, acts on the upper curved portion of the lower gripper 24 and holds the said gripper down so that it is separated from the upper gripper, and this is the position when the roller 32 is travelling over a dwell 33^a on the cam. At this time the hooks on the tapes feed the end of the unit being severed between the grippers. The roller 32, passing off the dwell 33^a, rides down the cam and lowers the carrier 25 and grippers, drawing the pin 27 away from the hook 28. The pin 27 strikes upon the ledge 29, and, being prevented from going lower, the under gripper 24 passes out from engagement with the pin, and its spring 26 throws said gripper upwardly, causing it to grip the paper against the underside of the upper griper. As the grippers continue their descent, they pull the paper down and release it from the adjacent hooks 21. At the same time the paper is released from the rear hooks by an arm or bale 35 that is mounted on a shaft 36, said shaft being oscillated by a rod 37 that is pivoted to a crank 38 mounted with the shaft, the rod 37 being reciprocated longitudinally by the action of a suitable cam (not here shown). A spring 39 on the shaft 36 tends to lower the arm 35.

Beneath the tapes 19 are a pair of cylinders 40 and 41 which are provided with creasing blades 42, there being a co-operating groove 43 in the opposing cylinders for such creasing blades. These cylinders are provided with air passages 44 extending from their hollow tubular axes radially outwardly to their surfaces, and pipes 45 (Figs. 9 and 10) communicate with the interior of the cylinders through the hollow journals referred to, said pipes being connected with any convenient suction apparatus. The journals and cylinders are cut out so that the cylinders rotating on the journals only permit communication between the interior of the cylinders and the suction pipes in certain phases of rotation of the cylinders. This suction is for the purpose of holding the ends, or free leaves 9 and 9^a of the units to the surface of the cylinders until the doubled edge of the next succeeding unit is inserted between them, as later described.

A tucker blade 46 is mounted in any desired way to make the middle fold 4 of the unit by thrusting the blade against the unit from above and folding it between the two cylinders 40 and 41. The tucker blade is mounted on arms 47 that are secured to a shaft 47^a carrying a crank 48 having a slot in its forward end which slides on a fixed pin 49, and being operated at its rear end by a cam 50, the reciprocation of this part causing the link 51 to reciprocate the crank 48 and thus to oscillate the arms 47 and raise and lower the tucker blade.

The grippers hold the forward end of the blank unit so that the tucker blade strikes the unit at a definite distance from its forward end, the slack all coming from the rear end of the unit or that end toward the cutters, and thus the middle fold 4 is formed in exactly the desired place. The tucker blade being mounted as it is, not only has an up and down movement, but has a component in the direction from the grippers

toward the ends of the unit, which component tends to take up any slack between the grippers and the center of the unit, and to insure that all the slack shall come from the other end of the unit. The downward movement of the grippers and the bale 35 carries the paper down against the surface of the cylinders 40 and 41 so that the suction can take hold of the paper.

The unit carried down by the tucker blade goes between the cylinders 40 and 41 and the creases 5 and 6 are made in opposite sides of the unit by the creasing blades 42 co-operating with the grooves 43. As the unit descends the air is exhausted from the interior of the cylinders and the free leaves 9 and 9ª of the unit are forced by the atmospheric pressure above the cylinders against the surface of the cylinders, holding them apart, a new unit being meanwhile brought into position and tucked between the said free leaves as they are closed together by the action of the cylinders.

As already stated, the web of paper is preferably wide enough to make a series of units side by side and the dividers 12 are sufficient in number to make the desired number of such units. The units after being prepared in the manner heretofore stated and after passing between the creasing cylinders 40 and 41, are delivered—preferably downwardly—to a series of folding devices below the creasing cylinders arranged likewise side by side to simultaneously fold the units last prepared and deliverd to them.

The folding devices are designed to fold the units into the zigzag shape shown in Fig. 4, in which the folds 5 and 6 will be projected in opposite directions, and to collapse the continuous chain of units into a package in the condition shown in Fig. 1.

To accomplish this, in the illustrative embodiment of the invention, rotating blades are provided disposed on opposite sides of the advancing sheet units and having parts designed, in the rotation of the blades, to engage opposite sides of each unit in order to accomplish the zigzag folding referred to. One rotating blade only may be used on each side of each sheet unit, but I preferably employ two rotating blades disposed on each side of each sheet unit, as shown in plan view in Fig. 8, and in which figure three sets of such rotating blades are shown for a series of three sheet units side by side across the web of paper, each set of folding devices comprising preferably, therefore, four rotating blades. In Fig. 8 the two rotating blades of each set on one side of the sheet are designated by the characters A, A′, while the two rotating blades of the same set on the other side of the sheet are designated by the characters B, B′. Obviously the number of sets of folding devices will depend upon the width of the paper web used and the number of units side by side in series to be prepared therefrom.

In the illustrative embodiments of my invention shown in Figs. 8 to 18, inclusive, the rotating blades are of disk-like form and of the countour in plan shown in Figs. 8 and 14, mounted for rotation upon an axis 52. Each rotating blade has what will be here termed a tail portion 53, defined in plan, as shown in Figs. 8 and 14, by a straight edge 54 on one side extending from the axis upon which the element is mounted, and by a curved edge 55 of comparatively large radius on the other side, meeting the straight edge at a point 56 forming the terminal of the tail portion and which terminal is the most remote point on the rotating blade from its axis. This rotating blade continues in what will be here termed a head portion 57, defined in plan, as shown in Figs. 8 and 14, by a curved edge of less radius than that of the tail portion and of progressively closer approach to the axis upon which the element is mounted. The head portion terminates in what will be here termed a tongue 58, defined in plan by an outer curved edge of still closer approach to the axis of rotation and by a re-entrant, curved inner edge forming an open notch about the axis of rotation.

The rotating blades are preferably assembled and mounted for rotation, as shown in Fig. 8, in the direction in which the tongues project. As will later be more fully pointed out, in order that the blades in rotating may perform a sweeping action across the sheets from the center line of the sheets outward toward their sides, the two blades of each set on the same side of the sheet,—as, for example, A, A′, and B, B′, —and also the two corresponding blades on opposite sides of the sheet,—as, for example, A, B and A′, B′,—are mounted for rotation in opposite directions.

While the rotating blades of the embodiments illustrated in Figs. 8 to 18, inclusive, are of the contour in plan referred to, the various parts of the blade are not in the same plane but, as shown particularly in Fig. 15, are in different planes. The tail portion 53 of each rotating blade is in substantially a horizontal plane, as shown in Fig. 15, while the head portion 57 is inclined upwardly in cup shape from the tail portion and from the axis 52 upon which the blade is mounted outwardly to the edge of the blade. This upward inclination continues also to a slight extent in tongue portion, as shown in Fig. 15, so that the tongue 58 is disposed substantially above the plane of the tail portion 53 and slightly inclined upwardly. Each rotating blade is, therefore, in the form of a spiral having its lowest plane and greatest radii in the tail portion and extending therefrom by gradual ascent

and progressively decreasing radii to the tongue portion, which is the portion of highest elevation and of least radius from the axis of rotation.

In the diagrammatic Figs. 21 to 25, inclusive, various positions of the blades of one set are shown, the two blades of the set on one side of the sheet to be folded being designated by the characters A, A′, and the two blades of the set on the opposite side of the sheet being designated by the characters B, B′, while the median, longitudinal line between the cylinders and the plane of the sheet to be folded is designated by the letter S.

With the rotating blades of the contour described and with the arrangement shown, it is to be observed that as the heads of the rotating blades on one side of the sheet,—for example, of the blades B, B′, and as shown in Fig. 8,—come into contactual relation with the sheet, the tails of the oppositely disposed rotating blades,—for example, the blades A, A′,—are in contactual relation with the opposite side of the sheet. This is also the position of the rotating blades A′, B′, shown in cross-sectional views of Figs. 12 and 13, and from the last-mentioned views it is to be observed that since the head and tail of each oppositely disposed blade are on different levels, and of differing contour, they perform different functions upon the sheet, the higher disposed and upwardly inclined head,—for example, as shown in the blade B′ in Figs. 12 and 13,—performing a folding action upon the advancing sheet, and the lower, flat tail portion of the oppositely disposed blade a compressing action upon the leaves of the sheet already folded. It is also to be observed that in the position of the two blades as shown in Figs. 12 and 13, the head of one blade overlaps the tail of the oppositely disposed blade.

Figs. 21 to 25, inclusive, show the different positions of the blades during the progressive rotation of the blades from the position shown in Figs. 8, 12 and 13. In Fig. 21, the tails of the blades A, A′ are shown to have been withdrawn from the position of compressing the last completely folded leaf underneath the one in process of being folded, and the tongues projecting from the head of these blades are shown approaching a folding relation to the sheet. The heads on the blades B, B′ are also shown as nearly withdrawn from their folding position on the sheet (shown in Figs. 12 and 13), and the tail portions as approaching to a compressing action on the sheet. Fig. 22 shows an advanced rotative position on these blades with the tail portion of the blades B, B′ in compressing relation with the sheet, while the heads of the blades A, A′ are in folding relation. Fig. 23 shows a reversal of the positions of the blades A, A′, B, B′ from those shown in Figs. 8, 12 and 13. Fig. 24 shows a reversal of the positions of the blades shown in Fig. 21, and Fig. 25 a reversal of the positions of the blades shown in Fig. 22.

Due to the creases made by the creasing cylinders in the paper on alternate sides thereof, causing partial folds in the paper, the sheets do not advance in a straight line but deviate therefrom to the right and to the left in zigzag fashion, as shown in Fig. 6; and due to this deviation, the upwardly inclined and advancing tongue on each of the blades is the part to first come into contactual relation with the sheet. The creasing cylinders and the rotating blades are co-ordinated in their rotation so that the sheet is advanced and the tongues rotated into contactual relation therewith alternately on opposite sides of the sheet between two oppositely disposed creases and hence into the V-shaped open recess of a crease. A continuation of the rotation of the blade, therefore, carries the tongue and the head behind it, and finally the tail, in downwardly inclined order and in circles of gradually increasing radii, forming the fold and gradually compressing the under leaf of that fold upon the series of leaves already completely folded and compressed.

It is also to be observed from a comparison of the position of the rotating blades in Figs. 21 to 25, inclusive, that the tails of the blades on each side of the sheet traverse substantially the entire width of the sheet by a sweeping motion in a curvilinear path in compressing the under leaf of the fold so that a very effective compressing action, with the avoidance of wrinkles, is obtained. The blades are preferably so arranged that the traverse of the blades will be from the center of the sheet outwardly toward its sides. In the present illustrative embodiment, I have shown the blades on both sides,—for example, the blades A, A′ and B, B′, as shown in Figs. 21 to 25, inclusive,—sweeping across the sheet from the center outwardly toward the sides, thus providing for a sweeping action across the paper simultaneously from the center outwardly toward both sides, which is very effective in folding the sheets and compressing the folded leaves with the avoidance of wrinkling.

As shown in Figs. 8, 9 and 10, rotation is imparted to one of the creasing cylinders—the left-hand one as viewed in Fig. 8—by a driving gear 59 intermeshing with a gear 60 on that cylinder, and rotation is imparted to the companion cylinder by a gear 61 on the opposite end of the first-mentioned cylinder intermeshing with a gear 62 on the same end of the companion cylinder. As shown in Figs. 8 to 16, inclusive, rotation is imparted to the spindle 63 (Fig. 16) of the rotating blades from the rotating creasing cylinders. Two horizontal and parallel

shafts 64 and 65 are provided, having gears 66 intermeshing with gears 67, one for each of the spindles of the rotating blades. The parallel shafts 64 and 65 are provided with gears 68 intermeshing with gears 69, which in turn intermesh with the gears 61 and 62, respectively, on the two creasing cylinders.

As shown in Fig. 16, the spindle 63 of each rotating blade is of substantial length, having a bearing in a journalled housing 70 attached to the supporting blocks 71 (Figs. 9, 15 and 16), in which the shafts 64 and 65 are also journalled. A ball bearing is provided for the lower end of the spindle by extending the journalled housing 70 downwardly in the form of an open yoke 72 (Figs. 9, 15 and 16), and into the open space of which yoke the lower end of the spindle extends. A screw 73 inserted upwardly through the lower arm of the yoke, provides a seat for the lower ball bearing 74, while a cavity in the lower end of the spindle provides a seat for the upper companion ball bearing 75. A collar 76 with a set screw 77 adjustably positions the spindle, while an additional adjustment for the ball bearings is provided because of the screw 73.

The spindle gear 67 is keyed to the spindle 63 by a key 78 so as to permit a vertical adjustment of the spindle in the manner already referred to. Above the gear 67 is a collar 79 surrounding the spindle and keyed thereto, to rotate therewith by the same key 78 already referred to, the upper end of the collar providing a rest for the rotating blade. The spindle 63 terminates a short distance below the upper end of the collar 79 and below the rotating blade, and into the upper extremity of this spindle is screw-threaded a spindle hub 80, forming the hub about which the central aperture of the rotating blade closely fits. The hub 80 is surrounded by a retaining cap 81, between which cap and that part of the rotating blade having the hub is a washer 82. It is obvious that when the hub 80 is tightly screwed downwardly into the spindle 63, and with the cap 81 in frictional contact with the rotating blade, the rotating blade is held to rotate with the spindle.

The stack of collapsed units is compressed into a receptacle, which, in the present instance, is a chute 83. Usually, in devices of this character, it is desirable to provide some form of resistance device in the chute for the stack of collapsed units until the chute has been filled or partly filled, so that the friction of the stack on the sides of the chute will afford such resistance. In the embodiment of my invention illustrated, however, I have found the folding and compression of the leaves by the sweeping action of the blades across substantially the entire width of the sheet so efficient that a resistance device in the chute is not essential.

By a comparison of Figs. 21 and 22, it will be observed that in the position of the rotating blades shown in Fig. 21, the tongue on each of the blades A, A′ comes into close proximity with the curved edge of the head portion of the blades B, B′, and that in passing from the position illustrated in Fig. 21 to the position illustrated in Fig. 22, the tongue on the blades A, A′ and the head and tail portions on the blades B, B′ sweep over and under the other respectively, and the overlapping portions of the blades, as shown in Figs. 12 and 13, approach each other sufficiently to form a sharp fold at the doubled edge indicated at E in the said figures.

In Figs. 17 and 18, however, I have shown a modification embodying the invention in which the rotating blade is permitted a slight vertical movement upon its spindle under a restraining spring so that the blades may be mounted for substantial contact between the parts sweeping across one another and to permit a slight separation of those parts in folding the paper therebetween.

In this modification the hub 80′, which is screw-threaded into the spindle 63, is extended upwardly an appreciable distance above the rotating blade so as to accommodate a spiral spring 84 surrounding the hub and between the cap 81′ thereon and the washer 82′ bearing on the rotating blade. This washer is provided with an upwardly extending sleeve, as shown in Fig. 18, surrounding the hub 80′, and between the hub and the spiral spring, so as to properly center the spring. In order to permit a vertical movement of the rotating blade under the restraining influence of the spring and yet cause the blade to rotate with the spindle 63, the washer 82′ is riveted to the blade, as shown at 85, and a pin 86 secured to this washer near its outer edge extends through an aperture provided therefor in the blade and into an extended slideway in the collar 79 which rotates with the spindle.

In describing the illustrated embodiments of my invention heretofore referred to, I have described the operation of the mechanism as I have described the successive parts thereof. It is not, therefore, deemed necessary to describe the operation in detail. The general operation of my improved folding device, in the operation of the machine in which it is associated, may thus be briefly stated: The web of paper 10 passes through the cutting and dividing mechanism and is cut into rows of units, which are transported by the mechanism described and forming no part of my present invention, and deposited upon the upper surfaces of the creasing cylinders 40 and 41, between which a tucker blade pushes the units in the form of a folded sheet of two leaves, the creasing cylinders creasing the sheet alternately on

opposite sides and delivering it downwardly to the folding devices, a new folded sheet being inserted between the free ends of the first-mentioned sheet before it completely passes through the creasing cylinders so that a continuous chain of such once-folded sheets is delivered to the folding devices for folding and compressing operations thereon.

As the rotating blades are of spiral form with the tongue portion at the highest point of the spiral and on the advancing side, and the tail portions are at the lowest point of the spiral and on the opposite side of the spiral, and as the blades of each set are oppositely disposed, the tongue portions are alternately thrust into the V-shaped recesses of the paper formed by the creases, and the tail portions alternately press down on the leaf of the fold underneath and hold it down. Thus while the tongue and the immediately following head portion of one blade are forming the fold, the tail portion of an oppositely disposed blade, projected therebeneath, is pressing downwardly upon a fold previously formed, the tail portion of the last-mentioned blade then being withdrawn to present the tongue and head portion of that blade over the tail portion of the first-mentioned blade which by that time has been projected into compressing position. The motion of the various parts of the two oppositely disposed blades is, therefore, like that of children's hands when they play a game in which one child places its hands upon the table and another child slaps its hands upon those of the child who first played, and then the child who first played withdraws its hands from beneath and places them upon the top again, and so on, except that the alternate advancing and withdrawal is by a sweeping, rotary motion of one part alternately over and under the other.

In Figs. 19 and 20 I have shown another embodiment of the invention in a modified form of rotating blade particularly adapted for folding highly finished paper as distinguished from a paper of rougher finish, such as used for towels.

Here the rotary blades are circular in contour in plan, as shown in Fig. 19,—that is, with the tongue portion 58′, the head portion 57′ and the tail portion 53′ having their curved outer edge equi-distant from the axis of rotation. As shown in Fig. 20, the form is retained in which the tongue portion is disposed at the highest level and the tail portion at the lowest and with the head portion on a gradual incline intermediate the two.

As also shown in Fig. 19, the tongue portion is lengthened substantially so that in plan view its free end completes the circle by approaching to the edge 56′ of the tail portion, although, as already stated, the tongue is disposed above the plane of the tail portion.

The conformation referred to is, therefore, such when these blades are mounted in the manner already referred to, and as illustrated in Figs. 8, 12, 13, 21 to 25, inclusive, to cause a continuous contactual relation of these blades with the paper to be folded and compressed, which is particularly effective in folding and compressing sheets of smaller size or of thinner and more delicate and more highly finished texture.

The rotating blades illustrated in Figs. 19 and 20 may be mounted as shown in Fig. 15 without the spring means or with such spring means as shown in Fig. 17.

The operation of the folding devices in making a package such as shown in Fig. 5 is substantially the same as that heretofore described in regard to the package shown in Figs. 3 and 4, although the machine for preparing the units and delivering them to the folding devices will either be of a different character than or contain certain modifications over the machine illustrated in Figs. 6 and 7. If such a machine as is illustrated in Figs. 6 and 7 is employed, the tucker blade 46 there shown will not be used to tuck the doubled edge of one sheet between the free ends of the sheet ahead of it, but each sheet will be delivered in unfolded condition to the creasing cylinders and with the sheets so overlapping that the advancing end of one sheet approaches close to the transverse center line of the sheet ahead. The creasing blades and grooves will also be so spaced as to make one crease at the transverse center line of each sheet and with successive sheets creased in alternate directions. A chain of overlapping and oppositely creased sheets will then be delivered to the folding devices in the same manner and in zigzag form as the chain of doubled and twice creased sheets shown in Fig. 6, and the folding devices will operate upon the chain of single overlapping sheets in the same manner as its operation upon the chain of doubled and partially interfolded sheets referred to.

If desired, two sheets precisely superposed may be employed in place of the single sheets in the chain of overlapping sheets referred to, in which case a package will be formed identical with that shown in Fig. 5, except that two precisely superposed units will appear instead of the single units shown in that figure.

Having described my invention, what I claim and desire to secure by Letters Patent is:

1. In an apparatus for folding a sheet into a plurality of leaves, the combination of creasing means and folding elements that receive the sheet directly from the creasing

means and that are constructed and arranged to engage said sheets on opposite sides thereof in a sweeping movement having a component parallel to the creases in said sheet.

2. In a sheet folding apparatus, means to alternately fold the sheet into a plurality of leaves, said means comprising sheet engaging elements having parts constructed and arranged to describe a sweeping motion in a horizontal plane having a component parallel to the creases in said sheet alternately on opposite sides thereof.

3. In an apparatus for folding a sheet into a plurality of leaves, sheet engaging elements on opposite sides of said sheet constructed and arranged to transverse overlapping paths in a sweeping movement having a component parallel to the creases in said sheet.

4. In combination with apparatus for folding a sheet into a double unit, of means to fold the said unit into a plurality of leaves, said means comprising sheet engaging elements constructed and arranged to describe a sweeping motion having a component parallel to the creases of said sheet alternately on opposite sides thereof.

5. In combination with apparatus for creasing sheets with a plurality of oppositely facing creases, of means for engaging the sheets to fold the same into a plurality of leaves, said means comprising sheet engaging elements that receive the sheet directly from the creasing apparatus and that are constructed and arranged to describe a sweeping motion having a component parallel to the creases in said sheets alternately on opposite sides thereof between said leaves.

6. In combination with apparatus for creasing sheets with a plurality of oppositely facing creases, of means for engaging the sheets to fold the same into a plurality of leaves, said means comprising sheet engaging elements that receive the sheet directly from the creasing apparatus and that are constructed and arranged to describe a sweeping motion having a component of motion parallel to the creases of said sheets alternately on opposite sides thereof in the V-shaped recesses provided by said creases.

7. In combination with apparatus for creasing sheets with a plurality of successively oppositely-facing creases, of means for engaging said sheets to fold the same into a plurality of leaves and for compressing said leaves, said means comprising sheet engaging elements that receive the sheet directly from the creasing apparatus and that are constructed and arranged to describe each a curvilinear path having a component of motion parallel to the creases of said sheets on opposite sides thereof simultaneously in the successive V-shaped recesses provided by said creases.

8. In combination with apparatus for folding a sheet into a double unit and for creasing said double unit parallel to its doubled edge with a plurality of oppositely facing creases, of means for engaging the double unit to fold the same into a plurality of leaves, said means comprising sheet engaging elements constructed and arranged to describe a sweeping motion having a component parallel to the creases of said sheet alternately on opposite sides thereof between said leaves.

9. In an apparatus for folding a sheet into a plurality of leaves extending from a common fold, the combination with means for advancing and for creasing said sheet, of means to form said fold, said folding means comprising a sheet-engaging element that receives the sheet directly from the creasing means and that is constructed and arranged to describe a curvilinear path in engagement with said sheet having a component of motion parallel to the creases of the sheet and a component parallel with the plane of said advancing sheet.

10. In an apparatus for folding a sheet into a plurality of leaves extending from a common fold, the combination with means for advancing said sheet, of means to form said fold and compress said leaves said folding and compressing means comprising a sheet engaging element constructed and arranged to describe a curvilinear path in engagement with said sheet, said path being about an axis that is approximately perpendicular to the creases of said sheet and said path having one component at an angle to the plane of said advancing sheet to form said fold and said path having a component at an angle to the plane of the leaves when the fold is formed to compress said leaves.

11. In an apparatus for folding a sheet into a plurality of leaves extending from a common fold, in combination with means for advancing said sheet, of means to form said fold and compress said leaves, said means comprising a sheet engaging element having parts constructed and arranged to successively engage said sheet in successive curvilinear paths of progressively increasing radii.

12. In an apparatus for folding a sheet into a plurality of leaves extending from a common fold, in combination with means for advancing said sheet, of means to form said fold and compress said leaves, said means comprising a sheet engaging element having parts constructed and arranged to successively engage said sheets in successive curvilinear paths of progressively increasing radii transversely to the plane of said advancing sheet.

13. In an apparatus for folding a sheet into a plurality of leaves extending from a common fold, in combination with means for advancing said sheet, of means to form said fold and compress said leaves, said means comprising a sheet engaging element having parts constructed and arranged to successively engage said sheets in successive curvilinear paths in successively descending horizontal planes.

14. In an apparatus for folding a sheet into a plurality of leaves extending from a common fold, in combination with means for advancing said sheet, of means to form said fold and compress said leaves, said means comprising a sheet engaging element having parts constructed and arranged to successively engage said sheets in successive curvilinear paths in successive descending horizontal planes and of progressively increasing radii.

15. In an apparatus for folding sheets into a plurality of leaves, in combination with means for advancing said sheets, of means to form said folds and compress said leaves, said means comprising sheet engaging elements disposed on opposite sides of said advancing sheets, said sheet engaging elements having parts constructed and arranged to successively engage said sheets in successive curvilinear paths in successive descending horizontal planes and of progressively increasing radii, one of said sheet engaging elements on one side of said sheets having its part describing the least radii and in the highest horizontal plane in engagement with said sheets at the time the oppositely-disposed sheet engaging element has its part describing the greatest radii and in the lowest horizontal plane in engagement with said sheet.

16. In an apparatus for folding sheets into a plurality of leaves, in combination with means for advancing said sheets, of means to form said folds and compress said leaves, said means comprising sheet engaging elements disposed on opposite sides of said advancing sheet, said sheet engaging elements each having parts constructed and arranged to successively engage said sheet in successive curvilinear paths of successively increasing radii in successively descending horizontal planes, said oppositely-disposed engaging elements being designed to simultaneously engage opposite sides of said sheet each alternately in relation of parts overlapping the other.

17. In an apparatus for folding sheets into a plurality of leaves, in combination with means for advancing said sheets, of means to form said fold and compress said leaves, said means comprising sheet engaging elements disposed on opposite sides of said sheet, each having parts constructed and arranged to successively engage said sheet in successive curvilinear paths in successively descending horizontal planes, said oppositely-disposed engaging elements being designed to simultaneously engage said sheet in overlapping relation of parts.

18. In an apparatus for folding a sheet into a plurality of leaves in combination with means for advancing said sheet, of means to form said fold and compress said leaves, said means comprising sheet engaging elements disposed on opposite sides of said sheet, each having parts constructed and arranged to engage said sheet in successive curvilinear paths in successively descending horizontal planes, said oppositely-disposed engaging elements being designed to simultaneously engage opposite sides of said sheet, each alternately in relation of parts overlapping the other.

19. In an apparatus for folding a sheet into a plurality of sets of leaves, the leaves of each set extending in the same direction from a common fold, in combination with means for advancing said sheet, of means for forming a plurality of said folds and for compressing said leaves, comprising sheet engaging elements disposed on opposite sides of said advancing sheet, constructed and arranged to engage said sheet in opposite directions in curvilinear paths having components parallel to the creases of the sheets, each of said curvilinear paths having one component at an angle to the plane of said advancing sheet to form a fold and a component at an angle to the plane of the leaves when the fold is formed to compress said leaves.

20. In combination with apparatus for creasing sheets with a plurality of successive oppositely-facing creases, of means for engaging said sheets to fold the same into a plurality of leaves and for compressing said leaves, said means comprising sheet engaging elements disposed on opposite sides of said sheets, each having parts constructed and arranged to successively engage said sheets in successive curvilinear paths in successively descending horizontal planes, said oppositely-disposed engaging elements being designed to simultaneously engage opposite sides of said sheets in successive V-shaped recesses provided by said creases, each alternately in relation of parts overlapping the other.

21. In combination with apparatus for creasing a sheet in a line parallel with an edge thereof, of means for engaging said sheet to fold the same into a plurality of leaves and for compressing said leaves, comprising a sheet engaging element having parts constructed and arranged to successively engage said sheet in the V-shaped recess provided by said crease in successive

curvilinear paths of progressively increasing radii.

22. In combination with apparatus for creasing a sheet in a line parallel with an edge thereof, of means for engaging said sheet to fold the same into a plurality of leaves and for compressing said leaves, said means comprising a sheet engaging element having parts constructed and arranged to successively engage said sheet in the V-shaped recess provided by said crease in successive curvilinear paths in successively descending horizontal planes and of progressively increasing radii.

23. In a sheet folding apparatus, means to fold sheets into a plurality of leaves extending alternately in opposite directions, said means comprising sheet advancing means, sheet engaging elements on opposite sides of said sheets mounted for rotation in a horizontal plane, said elements having parts in different horizontal planes, said elements being designed for simultaneous rotation to simultaneously engage opposite sides of an advancing sheet, each alternately in relation of parts overlapping the other.

24. In a sheet folding apparatus, means to fold said sheet into a plurality of leaves extending from a common fold, said means comprising a plurality of sheet engaging elements constructed and arranged to describe a sweeping motion progressively in opposite directions transversely of one side of said sheet.

25. In a sheet folding apparatus, means to fold sheets into a plurality of leaves extending alternately in opposite directions and to compress said leaves, said means comprising a plurality of engaging elements on each of the opposite sides of said sheets, said engaging elements constructed and arranged to describe a sweeping motion in a horizontal plane progressively in opposite directions transversely of each side of said sheets, said engaging elements having parts in different horizontal planes and said elements being designed for simultaneous movement to simultaneously engage opposite sides of said sheets, each of the engaging elements on one side sweeping through positions alternately in relation of parts overlapping the oppositely-disposed engaging element.

26. In a folding device of the class described, a rotatable folding blade having a head portion to engage the sheet to be folded and a spiral decline therefrom adapted upon the rotation of said blade to complete the fold and compress the folded sheet.

27. In an apparatus for folding a sheet into a plurality of leaves, sheet engaging elements disposed on opposite sides of said sheet constructed and arranged to normally traverse paths in contactual relation of parts of said sheet engaging elements, and means associated with said sheet engaging elements permitting divergence of said elements from said paths.

28. In an apparatus for folding a sheet into a plurality of leaves, sheet engaging elements disposed on opposite sides of said sheet constructed and arranged to normally traverse paths in contactual relation of parts of said sheet engaging elements, and spring means associated with one of said sheet engaging elements tending to restrain said element to its normal path but permitting divergence therefrom.

29. In an apparatus for folding a sheet into a plurality of leaves, sheet engaging elements disposed on opposite sides of said sheet constructed and arranged to normally traverse paths in contactual and overlapping relation of parts of said sheet engaging elements, and means associated with said engaging elements permitting divergence of said elements from said paths.

30. In an apparatus for folding a sheet into a plurality of leaves, sheet engaging elements disposed on opposite sides of said sheet constructed and arranged to normally traverse paths in contactual and overlapping relation of parts of said sheet engaging elements, and spring means associated with one of said engaging elements tending to restrain said element to its normal path, but permitting divergence therefrom.

31. In an apparatus for folding a sheet into a plurality of leaves, sheet engaging elements disposed on opposite sides of said sheet constructed and arranged to normally traverse paths in contactual relation of parts of said sheet engaging elements, and means associated with said sheet engaging elements permitting relative divergence of said elements.

32. In an apparatus for holding a sheet into a plurality of leaves, sheet engaging elements disposed on opposite sides of said sheet constructed and arranged to normally traverse paths in contactual relation of parts of said sheet engaging elements, and spring means associated with said sheet engaging elements tending to restrain said elements to their normal paths but permitting relative divergence therefrom.

33. In an apparatus for folding sheets into a plurality of leaves extending alternately in opposite directions from successive folds, in combination with means for advancing said sheets to said folding apparatus, of means to form said folds and compress said leaves, said means comprising sheet engaging elements mounted on opposite sides of said sheets on vertical axes for rotation normally in substantially the same planes, said axes being so disposed to

cause intersection of said paths of rotation, and spring means associated with said elements on said axes restraining said elements to rotation in said planes but permitting divergence therefrom at said point of intersection of said paths of rotation.

34. In an apparatus for folding sheets into a plurality of leaves extending alternately in opposite directions from successive folds, in combination with means for advancing said sheets to said folding apparatus, of means to form said folds and compress said leaves, said means comprising sheet engaging elements mounted on vertical axes on opposite sides of said sheet for rotation normally in substantially the same planes, each sheet engaging element being in the form of a rising spiral of decreasing radii from a substantially flat, horizontal tail portion to a projecting tongue, each sheet engaging element being mounted for rotation into engagement with an advancing sheet in the direction of projection of said tongue, said axis on opposite sides of said sheet being disposed to cause an intersection of said paths of rotation of said elements, and said elements being mounted upon said axes for simultaneous opposite phases of engagement of said spiral with said sheet.

35. In an apparatus for folding sheets into a plurality of leaves extending alternately in opposite directions from successive folds, in combination with means for advancing said sheet to said folding apparatus, of means to form said folds and compress said leaves, said means comprising sheet engaging elements disposed on opposite sides of said sheet, each sheet engaging element having a head portion designed to form said fold and a tail portion designed to compress said leaves, and means for moving said head and tail portions of said elements alternately and in opposite directions into engagement with said sheets.

36. In an apparatus for folding sheets into a plurality of leaves extending alternately in opposite directions from successive folds, in combination with means for advancing said sheets to said folding apparatus, of means to form said folds and compress said leaves, said means comprising sheet engaging elements disposed on opposite sides of said sheets, each said engaging element having a head portion designed to form said folds and a tail portion designed to compress said leaves, and means for moving the head portion of one element into engagement with said sheet simultaneously with the tail portion of the oppositely-disposed element.

37. In an apparatus for folding sheets into a plurality of leaves extending alternately in opposite directions from successive folds, in combination with means for advancing said sheets to said folding apparatus, of means to form said folds and compress said leaves, said means comprising sheet engaging elements disposed on opposite sides of said sheets, each said engaging element having a head portion designed to form said folds and a tail portion designed to compress said leaves, and means to impart a rotary movement to said elements to alternately engage said head and tail portions with an advancing sheet on opposite sides thereof.

38. In an apparatus for folding sheets into a plurality of leaves extending alternately in opposite directions from successive folds, in combination with means for advancing said sheets to said folding apparatus, of means to form said folds and compress said leaves, said means comprising sheet engaging elements disposed on opposite sides of said sheets, each said engaging element having a head portion designed to form said folds and a tail portion designed to compress said leaves, and means to impart a rotary movement to said elements to engage a head portion of one of said elements with an advancing sheet simultaneously with a tail portion of the oppositely-disposed element, and in opposite directions.

39. In an apparatus for folding a creased sheet into a plurality of leaves, the combination of means for creasing the sheet and a folding device that receives the sheet directly from the creasing means and that is rotatable in a plane parallel to the creases to be formed.

40. In an apparatus for folding a creased sheet into a plurality of leaves, the combination of means for creasing the sheet and a spiral device that receives the sheet directly from the creasing means and that is rotatable on an axis perpendicular to the creases to be formed.

41. In an apparatus for folding a creased sheet into a plurality of leaves, the combination of means for creasing the sheet and a folding device that receives the sheet directly from the creasing means and that is rotatable in a plane parallel to the creases to be formed, said device having a component of motion in a direction perpendicular to the creases to be formed.

42. In an apparatus for folding a creased sheet into a plurality of leaves, the combination of means for creasing the sheet alternately upon opposite sides and folding devices upon opposite sides of said sheet that are rotatable in planes parallel to said creases.

43. In an apparatus for folding a creased sheet into a plurality of leaves, the combination of means for creasing the sheet alternately upon opposite sides and folding devices upon opposite sides of said sheet, said

folding devices comprising spirals rotatable upon axes perpendicular to said creases.

44. In an apparatus for folding a creased sheet into a plurality of leaves, the combination of means for creasing the sheet alternately upon opposite sides and folding devices upon opposite sides of said sheet, said folding devices comprising spirals rotatable upon axes perpendicular to said creases, the turns of each spiral entering the recesses between the turns of its neighbor.

45. In an apparatus for interfolding sheets, means for alternately creasing sheets in opposite directions, means for engaging a leaf of one sheet in a fold of a preceding sheet, and spiral means that receive the sheet directly from the creasing means and that are rotatable upon an axis pendicular to said creases which are adapted to fold said sheets.

46. In an apparatus for interfolding sheets, means for alternately creasing sheets in opposite directions, means for engaging a leaf of one sheet in a fold of a preceding sheet, and spiral means that receive the sheet directly from the creasing means and that are rotatable upon an axis perpendicular to said creases which are adapted to fold and compress said sheets.

In testimony that I claim the foregoing, I have hereunto set my hand this 28th day of October, 1920.

SETH WHEELER.