United States Patent [19]

Sheroff et al.

[11] **3,753,558**

[45] **Aug. 21, 1973**

[54] **SHEET-FOLDING MACHINE**

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[73] Assignee: **Delfold Corporation**, New York, N.Y.

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[21] Appl. No.: **102,813**

[52] **U.S. Cl.** ..... **270/67**, 93/84 R, 270/39, 270/61 F, 270/73, 270/79, 270/84

[51] **Int. Cl.** **B65h 45/18**

[58] **Field of Search** 270/84, 85, 83, 79, 270/67, 62, 73, 61, 66, 39; 93/84

[56] **References Cited**

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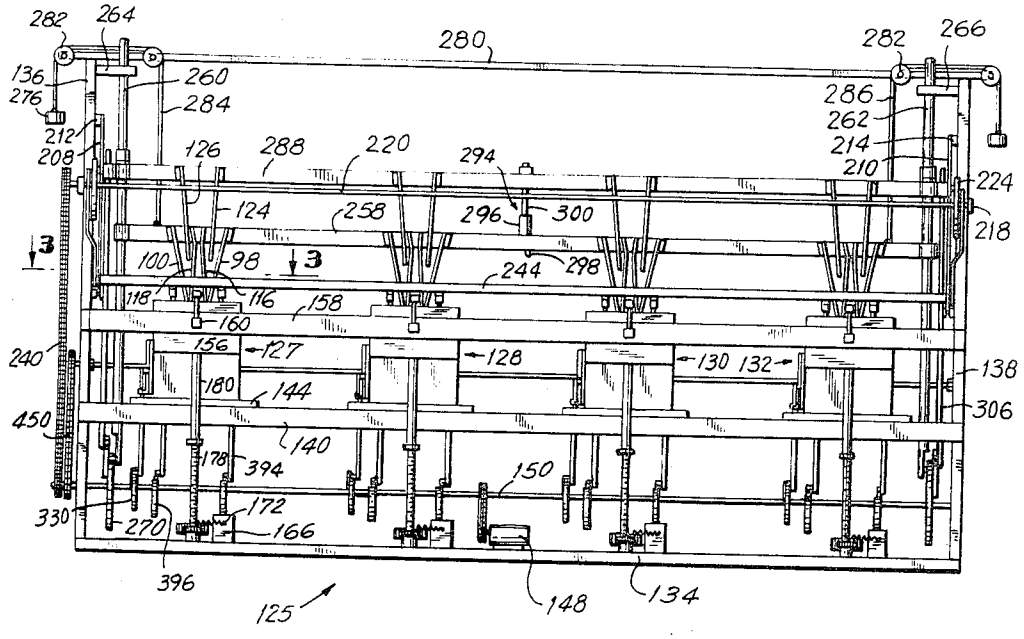
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Attorney—Steinberg & Blake

[57] **ABSTRACT**

A sheet-folding machine for providing a sheet with a V-folded portion and with pleats situated between the V-folded portion. The machine includes a pair of rolls for feeding and simultaneously creasing a sheet while the latter is advanced by the rolls along a predetermined feed axis located in a predetermined feed plane extending between the rolls parallel to the axes thereof. A folding assembly is provided for folding a V-fold in a sheet, and this folding assembly includes an outer pair of sheet-supporting plates situated equidistantly from the feed plane as well as a pair of inner folding plates inclined inwardly toward the feed plane to be received between the outer plates so as to form a V-fold in a sheet while the latter is advanced toward the rolls. A pair of pleating members are situated at least temporarily in the space between the outer plates on opposite sides of a pleating plane which contains the feed axis and is normal to the feed plane for forming side pleats in a sheet simultaneously with the formation of a V-fold therein. Thus, the sheet which is folded and creased by the rolls will have not only a V-folded portion but also at least a pair of pleats situated between the V-folded portion.

12 Claims, 15 Drawing Figures



8 Sheets-Sheet 1

FIG. 2

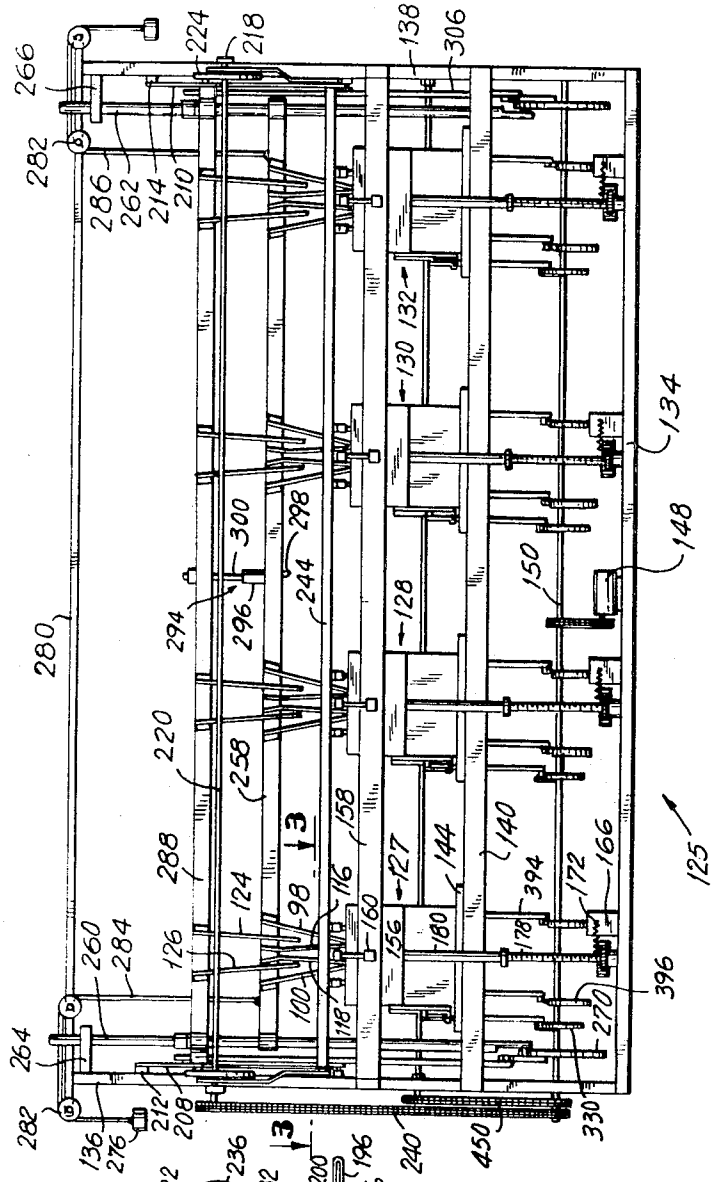


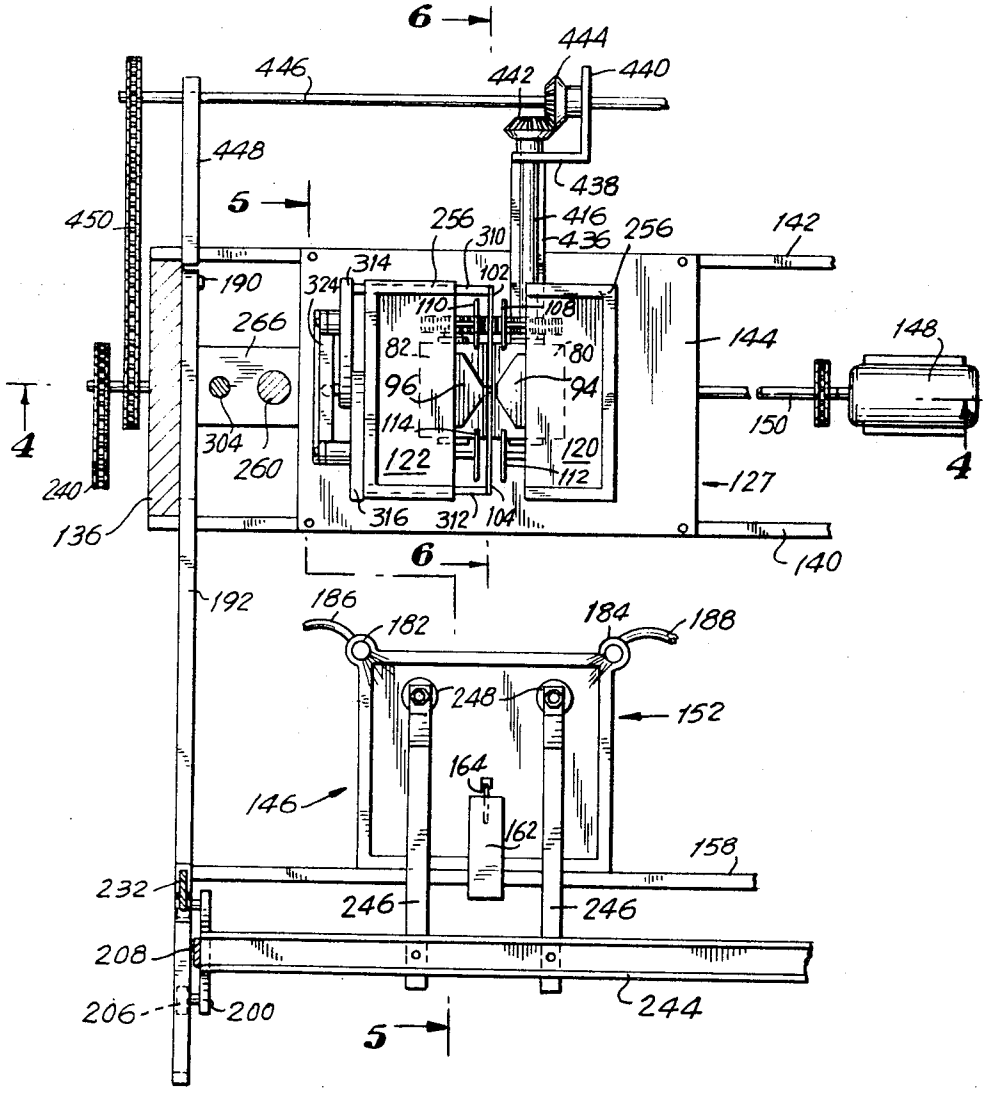
FIG. 1

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FIG. 3

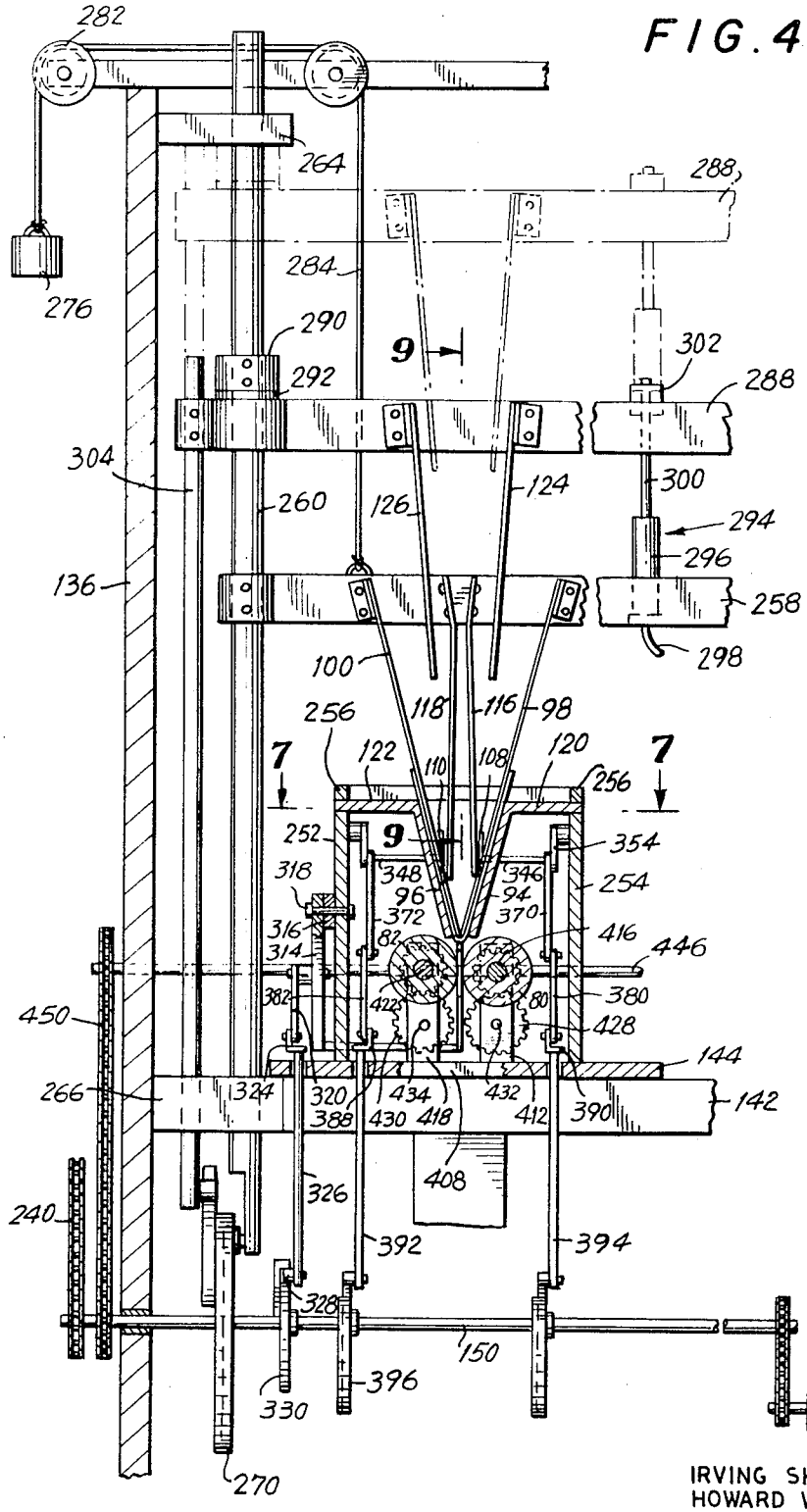


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FIG. 4



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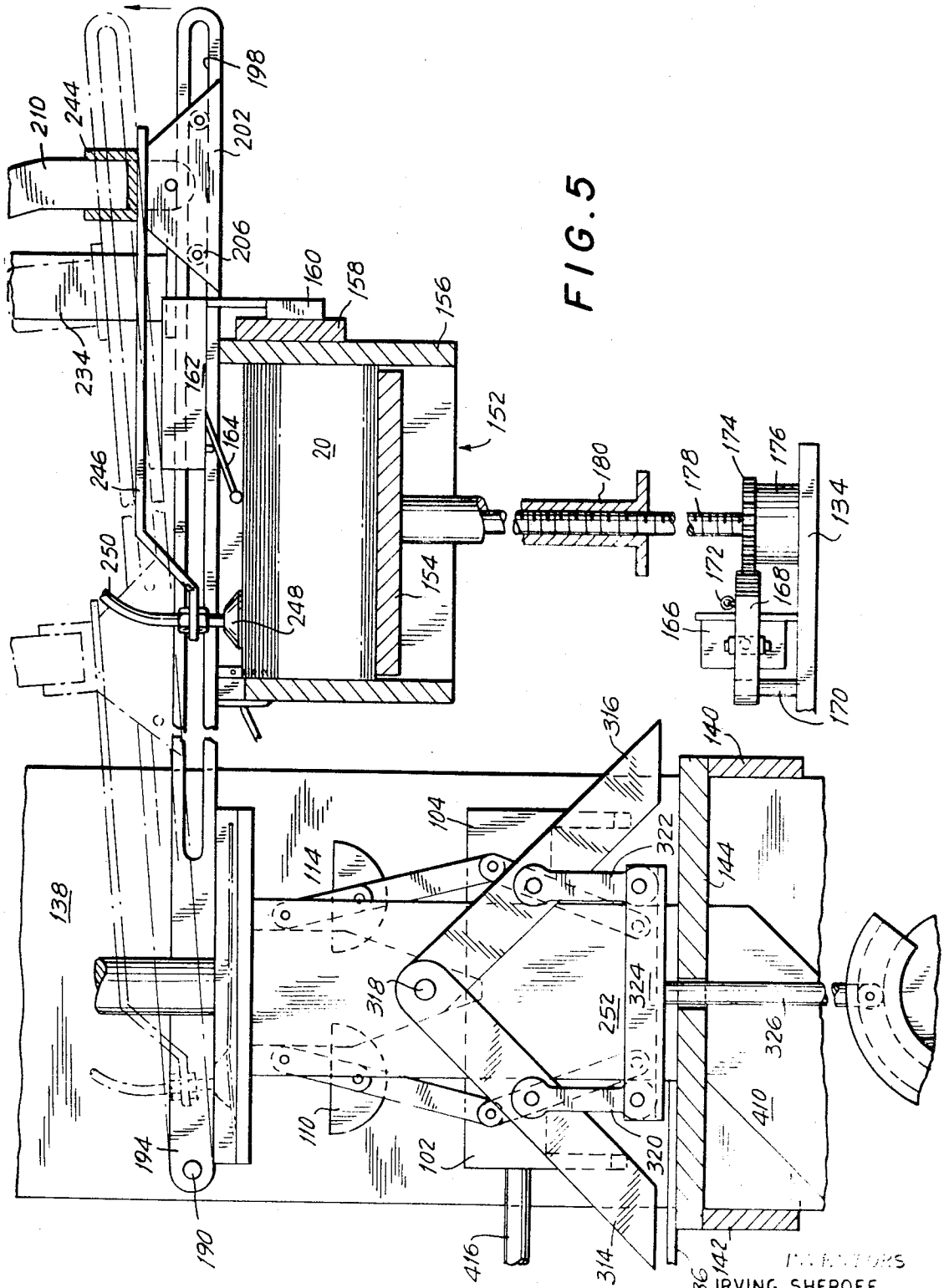


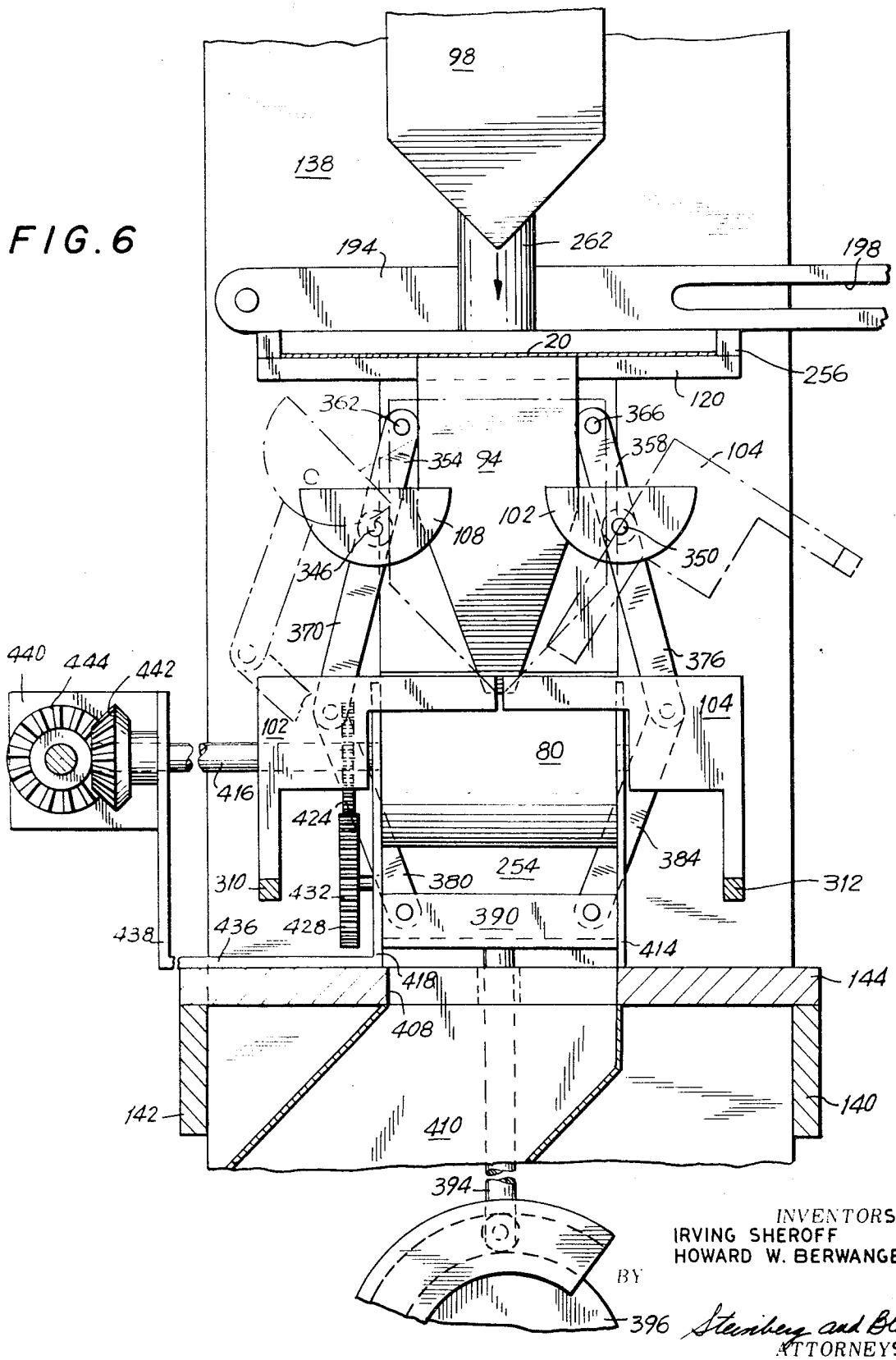
FIG. 5

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FIG. 6



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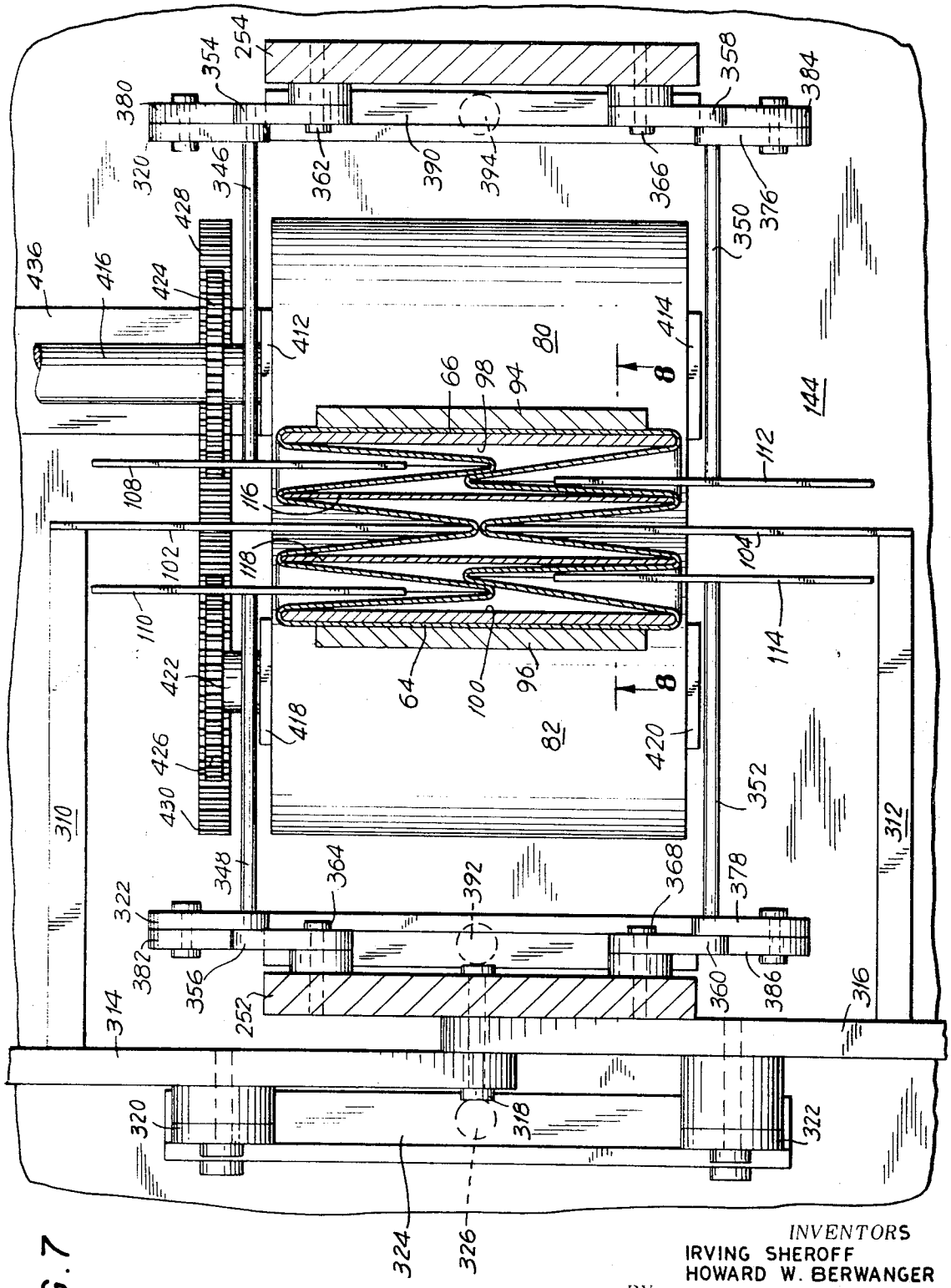


FIG. 7

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FIG. 10

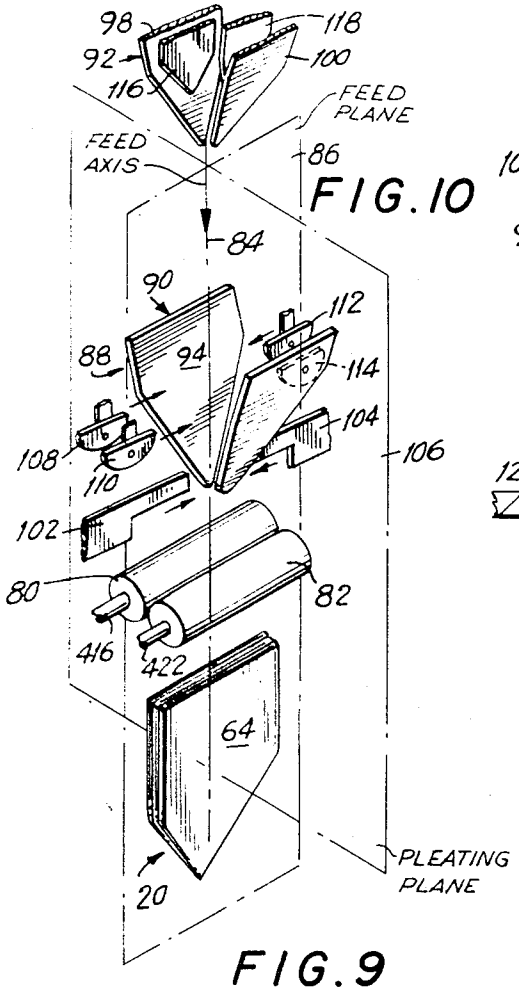


FIG. 8

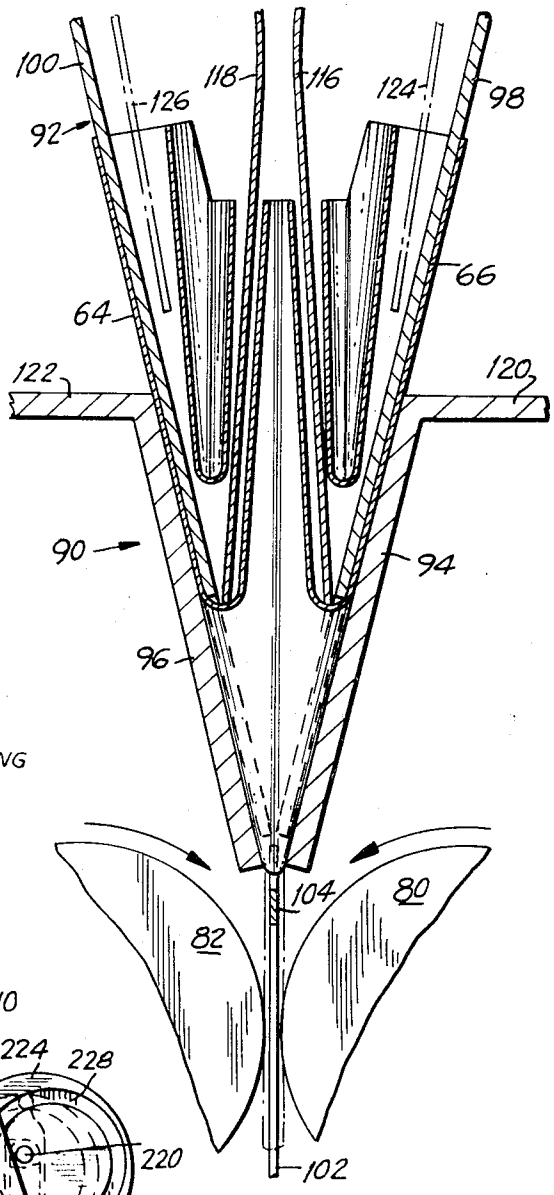
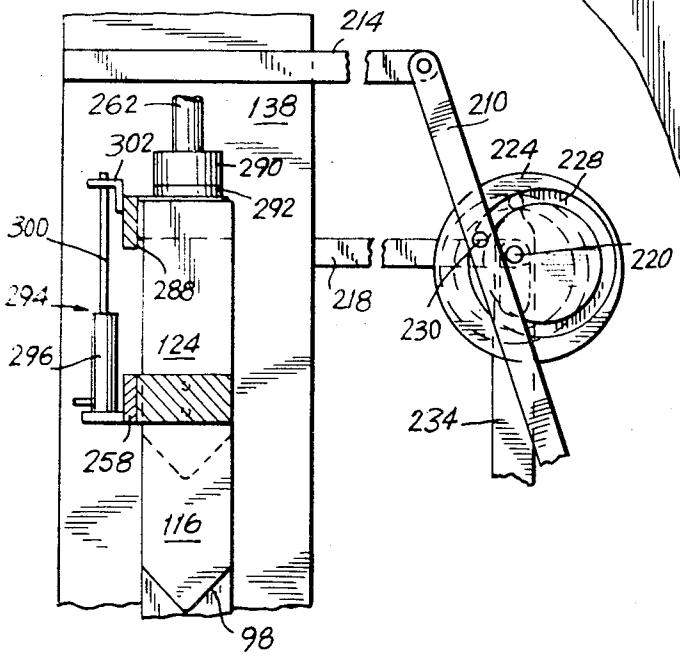


FIG. 9



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FIG. 11

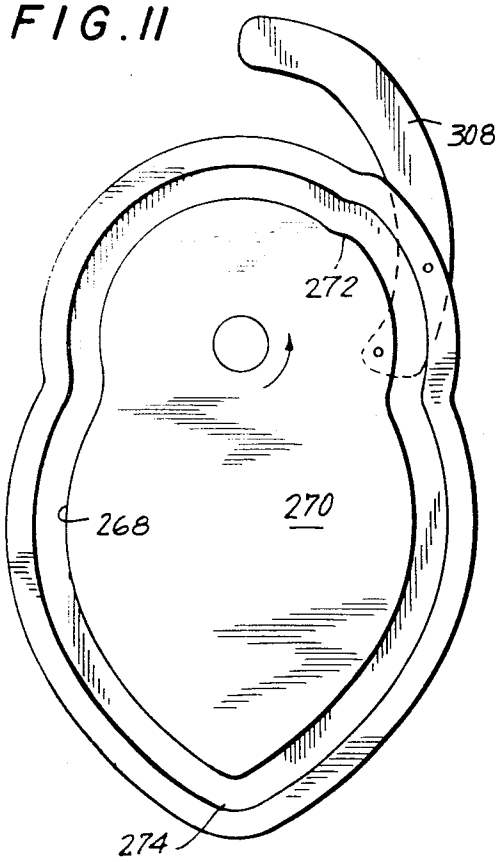


FIG. 12

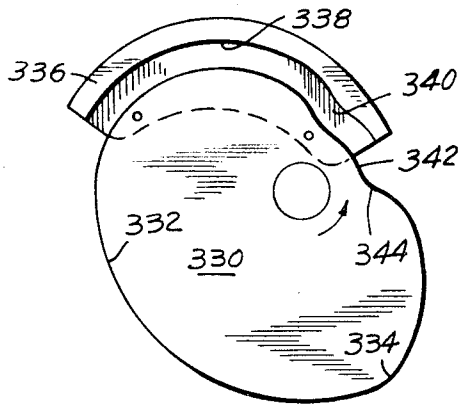


FIG. 13

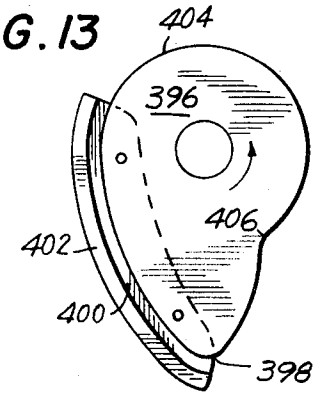


FIG. 14

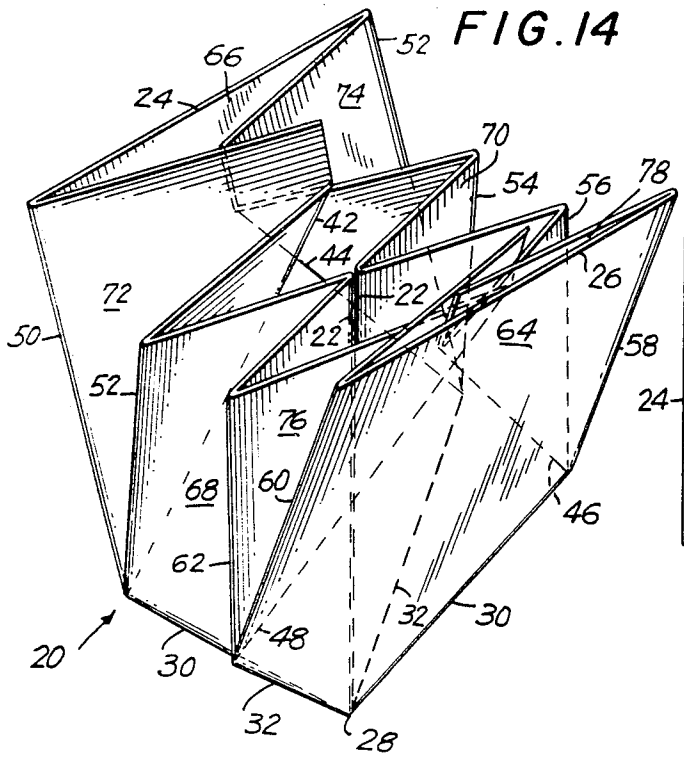
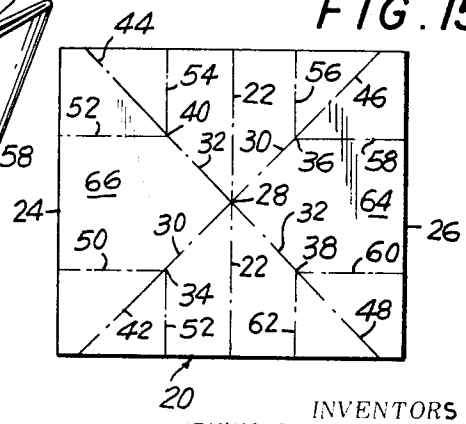


FIG. 15



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SHEET-FOLDING MACHINE

BACKGROUND OF THE INVENTION

The present invention relates to sheet-folding machines.

In particular, the present invention relates to that type of machine which is capable of automatically folding a sheet, such as a sheet of paper, in such a way that the sheet will be folded to have an outer V-shaped portion and side pleats situated between the outer V-shaped portion.

Sheets which are folded in this way are already known. They are carried, usually, by suitable V-shaped backers fixed to the outer V-folded sheet portion so that when the backer is unfolded the outer V-folded sheet portion is opened causing the pleated interior portions of the sheet to expand with the sheet assuming its flat, unfolded condition. Because of the inherent tendency of the sheet to return to its folded condition, such a unit is conveniently collapsed back to its folded condition where it occupies an extremely small amount of space.

Devices of this latter type may be very conveniently carried about in one's pocket, and the unfolded sheet may disclose a map, or similar subject matter, so that travellers in foreign countries or in unfamiliar cities can have access to a suitable map simply by opening the backer so as to unfold the sheet.

While devices of this latter type are known and widely used, because of the great convenience resulting therefrom, the presently known machines for folding the sheet are a source of considerable problems and disadvantages. At one time it was economically feasible to have such sheets folded by hand. However, because of the high costs of labor, attempts have been made to develop machines which will automatically fold the sheets, but the known machines which are available for this purpose are exceedingly complex and expensive, they require almost constant maintenance, their operation is unreliable, resulting in frequent shut-downs, their output is less than what is desired, and a uniform product of high quality cannot be achieved. The conventional machines require a large number of complex components, they occupy an exceedingly large amount of space, and the costs involved in installing such conventional machines and keeping them operating properly are prohibitive.

SUMMARY OF THE INVENTION

It is accordingly a primary object of the present invention to provide a machine capable of producing folded sheets of the above type while at the same time avoiding all of the above drawbacks.

Thus, it is an object of the invention to provide a machine of the above type which is exceedingly compact, requiring only a relatively small number of reliably operating elements, and which at the same time is capable of reliably producing with minimum maintenance operations and with minimum installation difficulties a high quality product at a high output.

A further object of the present invention is to provide a machine of the above type which will consume an exceedingly small amount of power while functioning to produce a high output of high quality products.

Also, it is an object of the present invention to provide a machine of this type which occupies such a small amount of space that a relatively large number of the

sheet-folding units can be provided in a single machine in order to multiply the output thereof, practically at will.

An additional object of the present invention is to provide a machine which requires no more manual operation than periodic replenishing of a supply of sheets which are to be folded.

A more specific object of the present invention is to provide a machine of the above type which is capable of carrying out all of the folding operations on a sheet while the latter moves through an extremely short distance in only a single direction.

In addition it is an object of the present invention to provide a machine of this type which will reliably strip the folded sheets from the components which fold the sheet, and which will operate on a sheet in such a way that the possibility of tearing or otherwise damaging the sheet is reliably avoided.

According to the invention the sheet-folding machine includes a pair of rolls which respectively have parallel axes of rotation and which are situated adjacent and on opposite sides of a predetermined feed plane which is situated between and parallel to the axes of rotation. These rolls operate to feed and simultaneously crease a sheet which passes between these rolls along a predetermined feed axis which is situated in the latter feed plane. A folding assembly is provided for forming a V-fold in a sheet which is received between the rolls this folding assembly being located ahead of the rolls, considered in the direction of sheet travel. The folding assembly includes an outer V-fold means and an inner V-fold means, the outer V-fold means having a pair of spaced sheet-supporting portions situated equidistantly from the feed plane on opposite sides thereof and defining between themselves a space through which the feed plane extends and across which a sheet initially extends before a V-fold is formed therein. The inner V-fold means is aligned with this latter space to be received therein for forming a V-fold in a sheet prior to feeding and creasing of the sheet by the rolls. A means is operatively connected with at least one of these V-fold means for advancing it along the feed axis with respect to the other of the V-fold means so as to situate the inner V-fold means in the space between the sheet-supporting portions to form a V-fold in a sheet. A pair of pleating members are situated on opposite sides of a pleating plane which is normal to the feed plane and which contains the feed axis. These pleating members are situated in the space between the sheet-supporting portions at least during part of the time that a sheet is folded by the folding assembly, so that the pleating members will form a pair of side pleats between a V-folded sheet portion during subsequent feeding and creasing of the sheet by the rolls. In this way the folded sheet will have an outer V-folded portion and at least a pair of inner pleats situated between the outer V-folded portion.

BRIEF DESCRIPTION OF DRAWINGS

The invention is illustrated by way of example in the accompanying drawings which form part of this application and in which:

FIG. 1 is an end elevation of a machine according to the invention;

FIG. 2 is a rear elevation of the machine of FIG. 1 as seen from the right of FIG. 1, FIG. 2 illustrating a ma-

chine where four units are provided for carrying out the folding operations;

FIG. 3 is a fragmentary partly sectional top plan view, taken along line 3—3 of FIG. 2 in the direction of the arrows, and showing details of one of the units, the scale of FIG. 3 being substantially greater than that of FIGS. 1 and 2;

FIG. 4 is a sectional elevation taken along line 4—4 of FIG. 3 in the direction of the arrows and illustrating details of the sheet-folding structure of one of the units;

FIG. 5 is a sectional elevation taken along line 5—5 of FIG. 3 in the direction of the arrows and showing further details of the structure, FIG. 5 in particular illustrating details of the sheet-supply means and the pleating structure;

FIG. 6 is a sectional elevation taken along line 6—6 of FIG. 3 in the direction of the arrows and illustrating further details of the pleating structure as well as part of the V-folding structure;

FIG. 7 is a sectional plan view taken along line 7—7 of FIG. 4 in the direction of the arrows and showing at a scale which is enlarged as compared to FIG. 4 the manner in which the V-folding and pleating structure acts on a sheet;

FIG. 8 is a sectional elevation taken along line 8—8 of FIG. 7 to illustrate further the condition of a sheet during the folding and pleating thereof;

FIG. 9 is a sectional elevation taken along line 9—9 of FIG. 4 in the direction of the arrows and illustrating controls of the sheet-supply means as well as the interconnection between part of the V-fold means and the stripper means;

FIG. 10 is a schematic perspective illustration of the manner in which the sheet-engaging components of a unit of the invention operate to produce the desired product;

FIGS. 11–13 respectively illustrate details of control cams;

FIG. 14 is a perspective illustration of the product produced by the machine of the invention shown in a partly open position; and

FIG. 15 is a schematic representation of a flat sheet, before it is folded, FIG. 15 illustrating the lines along which the sheet is folded and pleated.

DESCRIPTION OF PREFERRED EMBODIMENTS

GENERAL CONSIDERATIONS

Referring first to FIG. 15, the product produced by the machine of the invention is folded from a flat sheet 20 which may be any sheet of suitable paper which may have the generally rectangular or square configuration illustrated in FIG. 15. These sheets 20, before they are acted upon by the machine of the invention, will have suitable printed matter thereon, this printed matter being a map or the like, as pointed out above. Although, the sheet 20 is referred to as being made of paper, it is to be understood that the material used for the sheet 20 can be any material which is capable of having information printed thereon and which is capable of being folded. The sheet 20 is initially folded along the line 22 so that the opposed edges 24 and 26 thereof swing toward each other. In addition, the sheet 20 is pleated along the line 22 in opposite directions inwardly from the center point 28 of the line 22, which also forms the center of the sheet, so that the main central fold line also forms a pair of inner pleats in the sheet. The sheet is also pleated along the outer portions of the diagonal fold lines 30 and 32. Thus, the diagonal fold line 30 is pleated inwardly along the outer portions thereof up to the points 34 and 36, while the diagonal 32 is pleated inwardly along the outer portions thereof up to the points 38 and 40. In this way four outer pleats 42, 44, 46, and 48 are formed with the sheet being folded at its corner portions along the lines 50 and 52 between which the pleat 42 becomes situated, along the lines 52 and 54 between which the pleat 44 becomes located,along the lines 56 and 58, between which the pleat 46 becomes located, and along the lines 60 and 62, between which the pleat 48 becomes located.

The product of the invention is shown in a partly unfolded condition in the perspective illustration of FIG. 14 where the reference characters of FIG. 15 appear along the various folds and edges produced in the finished product by folding in the manner described above in connection with FIG. 15, so that by a comparison of FIG. 14 and FIG. 15 it is possible to visualize the manner in which the sheet is folded and pleated. Thus, it will be seen that the final product formed from the sheet 20 has an outer V-fold portion formed by the walls 64 and 66. Each of the walls 64 and 66 is generally rectangular at its upper portion but tapered along its lower portion up to the point 28 which is situated at the crest of the V-folded portion of the sheet. Between these walls 64 and 66 of the V-folded portion are the pair of inner pleats 68 and 70 formed along the line 22, and the inner folded edges of these inner pleats just come up to each other and are situated midway between the side edges 58 and 60 of the wall 64. On one side of the central pleats 68 and 70 are a pair of inner pleats 72 and 74, and it will be noted that the inner fold line 42 of the outer pleat 72 overlaps the inner fold line 44 of the outer pleat 74. These outer pleats 72 and 74 are situated between the inner pleats and the wall 66. A pair of additional outer pleats 76 and 78 are situated between the center or inner pleats 68 and 70 and the other outer wall 64, and the inner fold lines 46 and 48 of these pleats 76 and 78 also overlap each other.

A suitable backing sheet is V-folded and has its inner surfaces glued or otherwise fixed to the outer surfaces of the walls 64 and 66, so that the sheet can be collapsed into a substantially flat condition. When the backing sheet is opened, the walls 64 and 66 are pulled apart from each other so as to spread the sheet out back toward its condition shown in FIG. 15, thus making it easy to read the material printed on the sheet. The entire sheet is readily returned back to its folded condition because of the inherent tendency of the sheet to return to its collapsed condition. Because the backing sheet is glued only to the outer surfaces of the walls 64 and 66, the outer surfaces of the pleats are visible in the partly unfolded condition of the sheet, so that additional printed matter can be located at these parts of the sheet 20.

The manner in which the machine of the invention operates to produce from a flat sheet as shown in FIG. 15 a folded sheet as shown in FIG. 14 is illustrated in FIG. 10. Each unit of the machine includes a pair of creasing and feeding rolls 80 and 82 which are of an identical construction and which are situated next to each other in side-by-side relation. These rolls have parallel axes and they are driven in opposite directions so as to feed the sheet downwardly along a predetermined feed axis 84. This feed axis 84 is contained in

feed plane **86** which extends midway between and is parallel to the axes of the rolls **80** and **82**, so that the latter are located on opposite sides of while being closely adjacent to the feed plane **86**. A sheet-supply means, referred to in greater detail below, supplies the sheets **20** one after the other in flat condition, to a folding assembly **88** which is situated in advance of the feed rolls **80** and **82**, considered in the direction of sheet travel. Thus, where the axes of the rolls are horizontal, the folding assembly **88** is situated directly above or below the feed rolls.

The folding assembly **88** includes an outer V-fold means **90** and an inner V-fold means **92**. The outer V-fold means **90** has a pair of sheet-supporting portions having oppositely inclined sheet-engaging surfaces converging toward the rolls **80** and **82** and defining between themselves a tapered space through which the feed plane symmetrically extends, the pair of sheet-supporting portions being formed by a pair of plates which have lower parts **94** and **96** situated on opposite sides of the feed plane **86** equidistantly therefrom and being inclined inwardly and downwardly toward each other symmetrically with respect to the feed plane **86**, these parts **94** and **96** being tapered and terminating in the lower substantially pointed ends illustrated in FIG. **10**. At their upper ends the parts **94** and **96** are fixed with outwardly extending horizontal wings which are not in FIG. **10** and on which each sheet is deposited by the sheet-supply means. In this way each sheet will initially extend across the space which is defined between the sheet-supporting portion of the outer V-fold means **90**.

The inner V-fold means **92** has a pair of folding plates **98** and **100** which are also situated symmetrically with respect to the feed plane **86** on opposite sides thereof, these plates **98** and **100** also being inclined inwardly toward each other in a downward direction and terminating in the substantially pointed lower ends illustrated in FIG. **10**. Thus, the folding plates **98** and **100** are respectively of the same inclination as the sheet-engaging surfaces of the pair of sheet-supporting portions formed by the parts **94** and **96**, with these folding plates **98** and **100** also converging toward the feed rolls **80** and **82** and defining between themselves a tapered space through which the feed plane symmetrically extends. A means which is referred to below is operatively connected with the inner V-fold means **92** so as to lower it along the feed axis **84** without changing the inclination of the plates **98** and **100** so that the plates **98** and **100** will become situated between and closely adjacent to the parts **94** and **96** of the outer V-fold means **90**, and in this way the inner V-fold means **92** will be moved downwardly through the space across which the sheet initially extends in order to form a V-fold in the sheet along the line **22**, this fold being advanced in a manner described below downwardly beyond the parts **94** and **96** to be received between and engaged by the feed rolls **80** and **82** which continue the feeding of the sheet around the axis **84** while simultaneously creasing the sheet so that it travels down below the rolls **80** and **82** along the feed axis **84** in the condition illustrated in FIG. **10**.

A pair of inner pleating members **102** and **104** are located in the feed plane **86** on opposite sides of the feed axis **84** and on opposite sides of a pleating plane **106** which is normal to the feed plane **86** and which contains feed axis **84**. The inner ends of the pleating members **102** and **104**, which are closely adjacent to the feed axis **84**, are situated directly in the space between the parts **94** and **96** at the region of the lower tips thereof while the sheet moves down to the rolls **80** and **82**, so that the inner ends of these feeding members **102** and **104** form in the sheet the inner pleats **68** and **70**. Thus, it is these pleating members which pleat the sheet inwardly, causing the central fold line **22** to fold upon itself upwardly from the point **28**, simultaneously with the downward movement of the sheet to the feed rolls **80** and **82**. The pleating members **102** and **104** are located in their operative, pleating positions during the time when the sheet moves down beyond the parts **94** and **96** to the rolls **80** and **82**.

Each unit of the machine also includes four outer pleating members **108**, **110**, **112** and **114**, each of which is of a substantially semicircular configuration. In addition, the pleating structure includes a pair of pleating plates **116** and **118** which are situated between the folding plates **98** and **100** of the inner V-fold means **92**. These pleating plates **116** and **118** have lower portions which are oppositely inclined outwardly away from the feed plane **86**, with the plates **116** and **118** being situated on opposite sides of the feed plane **86** and being positioned symmetrically with respect thereto, so that in a downward direction the feeding plates **116** and **118** diverge apart from each other and approach the folding plates **98** and **100**, respectively. The outer pleating members are arranged two on one side and two on the other side of the pleating plane **106**. Thus, it will be seen that the outer pleating members **108** and **110** are situated on one side of the plane **106** while the outer pleating members **112** and **114** are situated on the other side of the pleating plane **106**. When the inner V-fold means **92** has been moved down sufficiently to locate the plates **98** and **100** next to the parts **94** and **96** with only the walls **64** and **68** of the sheet between the parts **94** and **96**, on the one hand, and the plates **98** and **100**, on the other hand, the outer pleating members are in alignment with the spaces between the pleating plates **116** and **118**, on the one hand, and the folding plates **98** and **100**, on the other hand, and at this time these outer pleating members are swung inwardly as indicated by the arrows in FIG. **10**, so that they enter between the plates **116**, **118**, on the one hand, and the plates **98**, **100**, on the other hand, so as to form in this way the pair of outer pleats **72**, **74**, **76**, and **78**. These pleats are formed around the pleating plates **116** and **118**.

Thus, referring to FIG. **8**, the outer V-fold means **90** is shown with the inclined parts **94** and **96** of the sheet-supporting portions which include the horizontal lateral extending wings **120** and **122** on which the sheet is initially deposited in the flat condition shown in FIG. **15**. The folding plates **98** and **100** are shown in their lower end positions extending through the space between the wings **120** and **122**, and the walls **64** and **66** of the sheet **20** are shown against the parts **94** and **96** of the outer V-fold means **90** as well as against the outer surfaces of the folding plates **98** and **100**. As is apparent from FIG. **8**, the inner tips of the pleating members **102** and **104** are situated at the elevation of the lower ends of the parts **94** and **96** to form the pair of inner pleats which become located along the feed axis. The pair of pleating members **108** and **112** enter into the space between plates **98** and **116** while the other pair of pleating members **110** and **114** enter into

the space between the plates **100** and **118**, so that in this way the pleats are formed around the pleating plates **116** and **118**.

A stripping means includes a pair of stripping plates **124** and **126**, shown in phantom lines in FIG. **8**, and these plates **124** and **126** are lowered in a manner referred to in greater detail below, so as to strip the sheet from the inner V-fold means **92** as well as from the pleating plates **116** and **118**, and deliver the tip of the sheet between the feed rolls **80** and **82** to be engaged thereby and fed along the axis **84**.

The operation is also apparent from FIG. **7** where the wall **64** is shown between the part **96** and folding plate **100** while the wall **66** of the sheet is shown between the folding plate **98** and the part **94**. The manner in which the inner pleating members **102** and **104** extend inwardly to a location close to the feed axis is particularly apparent. Also, FIG. **7** illustrates how the outer pleating members are situated to form the outer pleats. FIG. **7** particularly shows how the overlap between each pair of outer pleats is achieved.

After the above operations are completed the inner V-fold means **92** together with the pleating plates **116** and **118** are retracted upwardly back to their starting position and the next sheet is deposited upon the wings **120** and **122** of the pair of sheet-supporting portions of the outer V-fold means **90**. Then all of the above operations are repeated.

In the particular machine **125** of the invention which is illustrated in FIG. **2**, there are four identical units **127**, **128**, **130** and **132**, and all of these units operate in synchronism so as to simultaneously provide the products of the invention. Inasmuch as all of these units are identical, only the details of the unit **127** are described below, but it will be understood from the description that follows that various components of the several units are supported by common members which extend across the entire machine **125**. As may be seen from FIGS. **1** and **2**, all of the units are supported on a common base plate **134**. The pair of vertical end plates **136** and **138** extend upwardly from and are fixed to the base plate **134**. A rear supporting bar **140** extends between and is carried by the rear edges of the end walls **136** and **138**, while a front supporting bar **142** extends parallel to the rear supporting bar **140** and is also fixed to the end walls **136** and **138**, this front bar **142** being fragmentarily visible in FIG. **3**. Each unit has its own base plate **144** extending between and carried by the bars **140** and **142**, as shown for the unit **127** in FIG. **3**.

To the rear of the bar **140**, each unit is provided with a sheet supply means **146** described in greater detail below. Various components, including the sheet-supply means **146** communicate with a suitable source of compressed air in a manner described below.

The entire drive is taken from a single driving motor **148** carried by the base plate **134** and driving through a chain-and-sprocket drive, a cam shaft **150** which carries cams for providing the controls for the several units.

SHEET-SUPPLY MEANS

Referring to FIG. **5**, each sheet-supply means includes a box **152** formed by four vertical walls which are connected to each other so as to form an enclosure for receiving a supply of sheets **20**. From time to time the attendant will place sheets **20** in each box **152**. Each box **152** has a lower wall **154** which is displaced vertically in a manner referred to below. Each box **152** has a rear wall **156** which is fixedly carried by a transverse bar **158** extending between and carried by the end walls **136** and **138**. At each unit the bar **158** carries a bracket **160** on which a microswitch **162** is mounted. The microswitch **162** has a switch-actuating finger **164** which engages the top sheet **20** in the box **152**.

As the sheets **20** are taken one after the other from the top of the stack in the box **152**, the springy switch-actuating finger **164** expands downwardly, until it reaches a position where it will close the switch **162** so as to energize a solenoid **166** electrically connected into the circuit of the microswitch **162**. This solenoid **166** has a finger which engages a swingable gear sector **168** supported for swinging movement on a pin **170** carried by the base plate **134**. A spring **172** is operatively connected with the gear sector **168** so as to hold it yieldably in a rest position when the solenoid **156** is not energized.

When the solenoid **166** is energized, the armature thereof swings the gear sector **168**, and this gear sector **168** meshes with a gear **174** which acts through a one-way clutch **176** on a screw **178**. Thus, when the gear **174** is turned in one direction by the gear sector **168**, the drive is transmitted through the clutch **176** to the screw **178** so as to turn the latter, while when the solenoid **166** is unenergized and the spring **172** retracts the gear **168**, the gear **174** is turned in an opposite direction without transmitting any turning movement to the screw **178**.

This screw **178** is threaded into an elongated sleeve **180** which is fixed to the bottom wall **154** of the box **152**. Thus, each time the solenoid **156** is energized by the microswitch **162**, the screw **178** will be turned sufficiently to raise the floor **154** and move the switch-actuating finger **164** upwardly, so as to open the switch **162** and maintain the stack of sheets **20** at the desired elevation in the box **152**.

The front corners of the box **152** communicate with a pair of tubes **182** and **184** which in turn communicate through flexible lines **186** and **188** with a source of compressed air, so that in this way air can be blown into the front corners of the box **152** in order to maintain the sheets loose from each other at the upper region of the stack **20**. The tubes **182** and **184** are formed with openings communicating with the interior of the box **152** at the upper front corners thereof.

The end walls **136** and **138** fixedly carry pivots **190** on which a pair of arms **192** and **194** are swingably mounted. These arms extend rearwardly from the side walls **136** and **138** and are formed with elongated slots **196** and **198**.

A pair of carriages **200** and **202** are located respectively beside the arms **192** and **194** at the inner sides thereof, and these carriages have rollers **204** and **206** which roll freely along the interior of the slots **196** and **198**. The pair of carriages **200** and **202** are respectively fixed to a pair of upwardly extending arms **208** and **210**. These arms are pivotally suspended at their top ends from a pair of rearwardly directed supporting arms **212** and **214** which are fixed to and extend rearwardly from the walls **136** and **138** at the inner side surfaces thereof.

The outer surfaces of the pair of end walls **136** and **138** fixedly carry a pair of rearwardly directed supporting arms **216** and **218**. At their rear ends these arms

support for free rotary movement, in any suitable bearings, an elongated cam shaft **220**, and to this shaft there is fixed a pair of cams **222** and **224**. These cams are respectively provided at their inner surfaces with endless camming grooves **228** respectively receiving cam follower **230** projecting from the swingable arms **208** and **210**.

Along the outer side surfaces of the cams **222** and **224** are a pair of lifting arms **232** and **234**. These lifting arms **232** and **234** are respectively formed with vertical slots through which the cam shaft **220** passes (FIG. **9**). The bottom ends of the arms **234** are respectively fixed to the top edges of the swingable arms **192** and **194**. At their outer side surfaces the cams **222** and **224** are formed with endless camming grooves **236** which receive followers at the top ends of the lifting arms **232** and **234**, respectively.

Outwardly beyond the pair of walls **136** and **138**, the main drive shaft **150** drives a sprocket **238** which in turn drives a chain **240**. This chain drives a sprocket **242** fixed to one end of the cam shaft **220**, so that this shaft rotates continuously. The arrangement of the camming grooves of the cams **222** and **224** is such that the lifting arms **232** and **234** will swing the horizontal arms **192** and **194** around the pivots **190** while the arms **208** and **210** displace the carriages **200** and **202** back and forth along the slots **196** and **198**.

These carriages are fixed to the opposite ends of an elongated bar **244** which fixedly carries at each unit a pair of forwardly extending arms **246** which in turn respectively carry at their free ends a pair of suction cups **248** communicating with a source of suction through the flexible tubes **250**.

With this structure as the shaft **220** continuously rotates the cams **222** and **224** actuate the arms **232** and **234** as well as the arms **208** and **210** so as to raise the rear ends of the levers **192** and **194**, while suction is applied to the suction cups **248**, thus raising a sheet from the top of the stack. Then the arms **208** and **210** are swung forwardly at their lower ends, so that the carriages **200** and **202** move forwardly, causing the sheets to become located over the wings **120** and **122**. When each sheet is properly aligned with these wings of the outer V-fold means **90**, through unillustrated controls the suction at the suction cups **248** is terminated so that each sheet is released, and then the arms **208** and **210** are returned to the rear ends of the arms **192** and **194** while the arms **232** and **234** are lowered, so that the suction cups **248** engage the next sheet, and the next cycle of operations is ready to be repeated, the suction now being again applied through the lines **250**. In this way sheets are successively delivered one after the other to the outer V-fold means **90**.

From time to time the machine will be stopped and the operator will manually turn the screw **178** of each unit oppositely to the direction of turning it has when raising the floor **154**, so as to lower the floor **154**, and then the operator can simply slip a new supply of sheets beneath the suction cups into each box **152**. The machine is then started again and the operations continue.

SHEET-FOLDING ASSEMBLY

Referring to FIG. **4**, it will be seen that the base **144** of each unit fixedly carries a pair of upstanding side walls **252** and **254**. The top edge of the wall **254** is fixed to the outer edge of the wing **120** while the top edge of the wall **252** is fixed to the outer edge of the wing **122**, so that in this way the outer V-fold means **90** is fixedly supported and maintained stationary by a support means which is formed by the base **144** and walls **252** and **254**. Along its front and rear as well as outer side edge, each of these wings is provided with a rim **256**, so that these rims form lips for extending along the outer side edges of each sheet **20** in order to properly position it on the wings **120** and **122**.

The folding plates **98** and **100** of the inner V-fold means **92** are fixed at their top ends, through suitable brackets, to the rear surface of an elongated bar **258**, and it will be noted that this bar **258** is common to all of the units and carries the outer V-fold means of all of the units. Also it will be noted that through a suitable block and suitable fastening pins the pleating plates **116** and **118** are fixed to the rear surface of the common supporting bar **258**, so that these plates **116** and **118** will necessarily remain at predetermined positions with respect to the folding plates **98** and **100** (FIG. **4**).

The ends of the supporting bar **258** are fixed with a pair of vertically movable control rods **260** and **262**. Thus, each end of bar **258** may be formed with a suitable eye or sleeve, and the rods **260** and **262** respectively extend through these sleeves which are pinned or otherwise fixed to the rods by suitable cross pins, so that in this way the bar **258** will be compelled to move up and down with the rods **260** and **262**. Adjacent their upper ends, the walls **136** and **138** of the main frame respectively carry the bearing blocks **264** and **266** for the rods **260** and **262**. Also, at the elevation of the bars **140** and **142**, these end walls carry additional bearing blocks **266** for these rods, as is apparent from FIG. **3**.

At their lower ends the rods **260** and **262** respectively carry cam-follower rollers which are respectively received in the camming grooves **268** of a pair of rotary main cams **270**, one of which is shown in detail in FIG. **11**. These cams **270** are fixed to the main shaft **150** so as to rotate therewith, and through the cam-follower rollers at the bottom ends of the rods **260** and **262**, these rods are moved up and down in manner determined by the configuration of the camming groove **268** shown in FIG. **11**.

Each cam **270** will have the position shown in FIG. **11** when the rods **260** and **262** are at their lowest points, positioning the pair of folding plates **98** and **100** at their lowest points. As each cam **270** continues to turn in a counterclockwise direction as indicated by the arrow in FIG. **11**, the rods **260** and **262** will be raised slightly by the portion **272** of each camming groove, and then after remaining for a short dwell period at this elevation, the rods are raised until the cam **270** has been turned through **180°** from the position of FIG. **11** so that the outermost point **274** receives the cam-followers at the bottom ends of the rods **260** and **262**. This is a starting position where the pair of folding plates of the outer V-fold means is situated at the highest elevation, and then as the cams continue to turn the pair of folding plates **98** and **100** will be lowered, together with the pleating plates **116** and **118**, so that in this way the cycle of operation of the folding assembly is repeated.

Of course, the paper supply means has its operation timed with respect to that of the folding assemblies so that the sheets **20** are introduced at the several units at the time when the plates **98** and **100** are at their highest elevation.

The cam-followers at the bottom ends of the rods **260** and **262** are maintained at all times at the uppermost part of the cams **270** by a pair of weights **276** and **278.** The top ends of the walls **136** and **138** are interconnected by a top plate **280** of the main frame of the entire machine, and this plate is formed with suitable slots to support for rotary movement the guide pulleys **282** around which cords **284** and **286** are guided. These cords are fixed at their bottom ends to suitable rings or other fastening members fixed to the bar **258,** so that this bar together with the rods **260** and **262** is constantly urged upwardly by the weights **276** and **278.** Thus, the extent of upward movement of the bar **258** is limited by the coaction of the cam-follower rollers at the bottom of the rods **260** and **262** with the camming groove **268** of the main cams **270.**

STRIPPING MEANS

As was pointed out above in connection with FIG. **8,** the machine includes at each of the units a pair of stripping plates **124** and **126.** At each unit the pair of stripping plates **124** and **126** are fixed by suitable brackets to the rear surface of an elongated horizontally extending bar **288** which is common to all of the units and which is formed at its ends with suitable sleeve portions through which the rods **260** and **262** slidably extend. Over the bar **288** the rods **260** and **262** respectively fixedly carry collars **290** beneath which are rubber rings or cushions **292** so as to prevent direct engagement between the bar **288** and the collars **290** and so as to absorb the force of any impact when these components approach each other. The bar **258** fixedly carries on any suitable bracket a yieldable means **294** having an air cylinder **296** communicating with any suitable source of compressed air through a tube **298.** This air cylinder encloses a piston having a piston rod **300** fixed to a bracket **302** which is fixed to and projects from the bar **288,** so that this yieldable means seeks at all times to maintain the bars **258** and **288** at a given distance from each other with the bar **288** engaging the cushions **292** which are beneath the fixed collars **290.**

The ends of the elongated bar **288** of the stripping means are respectively fixed to a pair of outer rods **304** and **306** which carry at their lower ends inwardly directed cam-follower rollers. It will be noted from FIG. **11** that the main cam **270** fixedly carries at its outer surface, which is opposed to the surface formed with the groove **268,** a camming finger **308,** and it is this finger which coacts with the follower rollers at the bottom end of the rod of the stripping means in order to provide relative movement between the bar **288** and the bar **258** in opposition to the force of the yieldable means **294.** It will be noted from FIG. **2** that there are only two main cams **270** for the entire series of units, and these cams coact with the rods adjacent the end walls **136** and **138** to provide a movement to the bars **258** and **288** wich is common for all of the units.

Thus, with this construction the yieldable means **294** will normally maintain the bar **288** at a given distance from the bar **258,** and all of the operations will take place without operation of the stripping means. However, it will be noted from FIG. **11** in particular that when the cam **270** is at a position situating the inner V-fold means **92** at its lowest end position, at the end of the folding operation, the fingers **308** will simultaneously move at opposite ends of the entire machine over the follower rollers at the bottom ends of the rods **304** and **306,** so that while the folding plates **98** and **100** dwell at their bottom end positions the fingers **308** coact with the rods **304** and **306** to lower the bar **288** in opposition to the yieldable means **294** so as to bring the stripping means into operation.

At each unit the pair of stripping plates **124** and **126** will thus move down, in response to the action of the fingers **308** of the main cams, so as to engage the folded sheet material and advance it further down from the folding plates, and this additional increment of movement derived from the stripping plates is sufficient to advance each sheet into the nip between the feed rolls **80** and **82.** It will be noted, from FIG. **4,** for example, that the pleating plates **116** and **118** terminate at a substantial distance above the bottom ends of the folding plates **98** and **100,** and in addition these pleating plates **116** and **118** are made of a springy metal, so that the stripping plates **124** and **126** easily displace the bottom ends of the pleating plates **116** and **118** inwardly toward each other while the stripping plates **124** and **126** move down to the bottom of the folded sheet for continuing the advancing thereof to the feed rolls while at the same time stripping the sheet from the folding plates.

A particular feature of the invention which is to be noted in this connection is the configuration of the groove **268,** shown in FIG. **11,** according to which this groove has the curved portion **272** which functions to raise the folding plates **98** and **100** slightly simultaneously with the continued downward movement of the stripping plates. Thus, the stripping action takes place as a result of the downward movement of the stripping plates as well as a simultaneous slight retraction of the folding plates **98** and **100,** and this combination of actions has been found to be highly effective in bringing about a rapid, faultless stripping action.

Of course, when the fingers **308** of the cams **270** move beyond the follower rollers at the bottom ends of the rods **304** and **306,** the pressure in the cylinder **296** of the yieldable means **294** acts to raise the bar **288** until it engages the cushions **292** beneath the collars **290,** and thus the stripping means is returned to its rest position with respect to the inner V-fold means, in preparation for the next cycle of operations.

PLEATING MECHANISM

As was pointed out above in connection with FIG. **10,** each unit is provided with a pair of inner pleating members **102** and **104** and with four outer pleating members **108, 110, 112** and **114.**

The pair of inner pleating members **102** and **104** are in the form of relatively thin plates made of any suitable metal, for example. They have the configuration shown most clearly in FIG. **6** where they are illustrated in their operative positions with their inner tips located directly next to and on opposite sides of the feed axis **84.** As was pointed out above these members **102** and **104** are situated directly in the feed plane where they remain at all times. Each of the members **102** and **104** is of a substantially L-shaped configuration, except that it has a substantially square configuration at the junction between the legs, as is apparent from FIG. **6.**

These inner pleating members **102** and **104** are respectively fixed to ends of a pair of horizontal rods **310** and **312,** which are of square cross section. These rods **310** and **312** are respectively fixed at their ends distant from the pleating members **102** and **104** to a pair of

swing levers 314 and 316 shown most clearly in FIGS. 5 and 7. The side wall 252 of each unit fixedly carries a pivot 318 (FIG. 4), and the levers 314 and 316 are swingable on this stationary pivot 318. A pair of links 320 and 322 are pivotally connected with swing levers 314 and 316, respectively, on suitable pins fixedly carried thereby, and suitable spacers are interposed between the levers and the links so that the links 320 and 322 will be situated in a common plane, as is apparent from FIG. 7.

The bottom ends of the links 320 and 322 are pivotally connected with a cross member 324 in the form of an angle bar, as is apparent from FIG. 4. Thus, the vertical web of this bar is pivotally connected with the links 320 and 322 while the lower horizontal web of the angle member 324 is fixed to the top end of a vertically extending rod 326, guided for movement through a suitable opening formed in the base plate 144 of each unit. The lower end of this vertically extending rod 326 carries a follower roller 328 which coacts with a cam 330 which is fixed to the elongated main shaft 150.

The configuration and details of the cam 330 are most clearly shown in FIG. 12. Also, FIG. 6 shows the end positions of the inner pleating member 104. Thus in the lower solid line position the inner pleating member 104 is shown in its operative position where the inner tip will provide one of the inner central pleats of the folded product. In the upper inclined dot-dash line position the pleating member 104 is in an inoperative position still extending into the space between the sheet-supporting portions of the outer V-fold means 90, but displaced from the lower tip of the stationary parts 94 and 96. The other pleating member 102 assumes at all times a position which is symmetrical with respect to the member 104.

It is apparent that when the cross-bar 324 is in its position shown in FIG. 5, directly above the base plate 144, the swing levers 314 and 316 have been swung to their lowest elevations and the inner pleating members 102 and 104 are in their operative positions. However, when the bar 324 is raised, the lever 314 will swing in a clockwise direction while the lever 316 will simultaneously swing in a counterclockwise direction, and this will displace the inner pleating members 102 and 104 to their rest or inoperative positions shown in dot-dash lines for the member 104 in FIG. 6.

Referring to FIG. 12, the cam 330 rotates in a counterclockwise direction, as indicated by the arrow. This cam 330 has an outer edge portion 332 which coacts with the follower roller 328. The part of the edge 332 extending from the tip 334 of the cam all the way up to member 336 corresponds to the raised position of the cross-bar 254 when the pleating members 102 and 104 are raised in their inclined inoperative positions and it is at this time that a sheet 20 which has been deposited upon the wings 120 and 122 is acted upon by the inner V-fold means 92 so as to be displaced down into the space between the inclined stationary plate portions 94 and 96 of the outer V-fold means 90. As is apparent from the dot-dash line position shown for element 104 in FIG. 6, at this time the sheet will initially have the center pleats 68 and 70 formed therein simply by downward movement of the sheet with respect to the pleating members 102 and 104 which remain at their rest positions.

The cam 330 has fixed thereto the camming member 336 which defines with the outer edge 332 of the cam a camming groove 338 which receives the follower roller 328 so that the latter will be positively pulled downwardly. This downward pulling lowers the cross-bar 324 to its lower end position shown in FIG. 5. As a result the sheet which has had the center pleats 68 and 70 initially formed therein simply by downward movement of the sheet with respect to the stationary pleating members 102 and 104 which are in their rest positions, will now have the formation of the center pleats continued until the pleats are provided with their inner edge portions 22 extending along the feed axis, because the inwardly swinging inner pleating members 102 and 104 will now push with their inner tips against the sheet along the line 22 so as to complete the formation of the inner pair of central pleats. By the time the part 340 of the groove 338 has reached the cam-follower roller 328, the inner movement of the pleating members 102 and 104 has been completed, and along the curved portion 342 the pleating members 102 and 104 dwell at their innermost operative positions, and it is during this time that the stripping action takes place and the sheet 20 continues to be advanced downwardly by the feed rolls 80 and 82 while the pleating members 102 and 104 remain at their operative positions thus forming an effective guide which results in the final formation of the central inner pleats 68 and 70.

As the cam 330 continues to turn the point 344 of its edge 322 will reach the cam-follower roller and from this point to the point 334 the bar 324 will be raised so that the inner pair of pleated members 102 and 104 will now return to their rest positions in preparation for the next cycle.

The semicircular outer pleating plates 108, 110, 112, and 114 are in the form of relatively thin sheet metal members fixed, as by welding or any other suitable means, to the free ends of horizontally extending rods 346, 348, 350, and 352, all of which are made of any suitable substantially rigid metal. These rods are of circular cross section and at their ends distant from the pleating members are respectively fixed to links 354, 356, 358, and 360. These links are swingably mounted at their upper ends on pivots 362, 364, 366 and 368, respectively, the pivots 362 and 366 being carried by the wall 254 while the pivots 364 and 368 are carried by the wall 252, and it will be noted from FIG. 7 that suitable spacers are interposed between these walls and the upper links which have their bottom ends fixed to the rods 346, 348, 350, and 352.

These rods serve at their ends which are respectively fixed to these links as pivots for intermediate links 370, 372, 376, and 378. These intermediate links are in turn pivotally connected with lower links 380, 382, 384, and 386. At their lower ends the lower links 382 and 386 are pivotally connected with a cross-bar 388, while the lower links 380 and 384 are pivotally connected at their lower ends with a cross-bar 390. As is apparent from FIG. 4, these cross-bars are also in the form of angle members. As may be seen from FIG. 6, when the angle member 390 is at its lowermost elevation the pleating members 108 and 112 have been swung inwardly to their operative positions shown in FIG. 7. When the bar 390 is raised the links 380 and 384 move upwardly to swing the intermediate links 370 and 376 apart from each other, thus resulting in swinging of the upper links 354 and 358 also outwardly apart from each other around the upper pivots 362 and 366. In this way the pleating member 108 is displaced to the dot-

dash line position shown in FIG. 6, and the other pleating member 112 is simultaneously displaced to a corresponding position. Also, the other pair of pleating members 11o and 114 are acted upon in precisely the same way through the linkage at the other wall 252, as a result of the vertical movement of the bar 388.

These bars 388 and 390 are fixed to the top ends of rods 392 and 394 which in turn carry at their lower ends cam-follower rollers which respectively coact with a pair of cams 396. These cams 396 each have the construction shown in FIG. 13 and a pair of these cams are provided at each unit to coact with the rods 392 and 394 thereof.

As may be seen from FIG. 13, each cam 396 has an outer tip 398 which when it engages a follower roller situates the rod connected thereto at its highest elevation. Thus, when the tip 398 engages a follower roller the pleating members are in their outer inoperative positions. As the cam 396 rotates in a counterclockwise direction, as indicated by the arrow in FIG. 13, the follower roller enters into a camming groove 400 defined between the outer edge of the cam and an angle plate 402 fixed thereto. The result is that the radial distance of the cam-follower roller from the center of the cam diminishes and the rods coacting with the cams 396 at each unit are pulled downwardly until the end of angle member 402 moves beyond the cam-follower roller. Now the roller will engage the circumferential edge portion 404 of the cam and will dwell at this time until the point 406 of the camming edge reaches the cam-follower roller. While the pleating members 108, 110, 112, and 114 remain at their inner operative positions, they coact with the plates 116 and 118 for providing the outer pairs of pleats simultaneously with the continued downward movement of each sheet 20, as is shown in FIG. 7. FIG. 7 illustrates that the pleating members 108 and 110 are situated more distant from each other than the pleating members 112 and 114, so that in this way the paper of each sheet 20 which folds inwardly in response to the action of the pleating members forms the pairs of overlapping pleats illustrated in FIG. 7. The members 112 and 114 will thus form the outer side pleats 72 and 76 which at their inner regions will be situated between the outer pleats 74 and 78 which are respectively formed by the members 110 and 108.

During the time when the outer pleating members are in their inoperative positions, shown in dot-dash lines for the member 108 in FIG. 6, they also have edges inclined inwardly and downwardly toward the pleating plane, as was the case with the upper edges of the inner pleating members 102 and 104, and in this way during the downward movement of each sheet 20 from the wings 120 and 122, by the inner V-fold means 92, the sheets will engage these straight edges of the outer pleating members in order to initiate the formation of the outer pleats. When these members 108, 110, 112, and 114 are swung inwardly during downward movement of the bars 388 and 390, they deepen the pleats, buckling the sheet 20 inwardly until it has the configuration illustrated in FIG. 7, and when the sheet is stripped in this configuration the subsequent feed rolls 80 and 82 complete the creasing of the sheet as well as continuing the feeding thereof.

As was pointed out above, this operation will take place during the dwell of the cam-follower rollers along the edge portion 404 until the point 406 is reached. At this point the several cams 396 will raise all of the outer pleating members back to their rest positions, in preparation for the next operating cycle.

FEED ROLL MECHANISM

As is apparent from FIG. 6, the base plate 144 of each unit is formed with a central opening 408 through which the finished product falls from the feed rolls 80 and 82 into a chute 410 which directs the finished products at each unit to a location from where they may be taken for further processing. This base plate 144 is of course formed with the openings for the rods 326, 392, and 394, at each unit, and the opening 408 is situated between the openings for the rods 392 and 394. Adjacent the front and rear edges of the opening 48, each base plate 144 fixedly carries a pair of upstanding plates 412 and 414 which carry bearings for a rotary shaft 416 on which the roll 80 is fixed. A similar pair of upstanding plates 418 and 420 are provided with suitable bearings for a shaft 422 on which the roll 82 is fixed. The shafts 416 and 422 fixedly carry in front of the rolls pinions 424 and 426. These pinions respectively mesh with gears 428 and 430 which mesh with each other. These gears 428 and 430 are respectively supported for free rotary movement on pins 432 and 434 which are respectively carried by and project forwardly from the front upstanding members 412 and 418.

The upstanding member 418 at each unit extends upwardly from the rear end of a horizontally extending wall 436 which is fixed to the top surface of the base plate 144 and which at its front end, situated forwardly beyond the base plate 144, carries an upstanding member 438. The wall 438 at its upper region has an angle extension 440, as is apparent from FIGS. 3 and 6.

The shaft 416 at each unit extends through a suitable bearing in wall 438 and fixedly carries at its front end a bevel gear 442. This gear 442 of each unit meshes with a bevel gear 444. The bevel gear 444 of the several units are mounted on a common shaft 446 supported for rotary movement not only by the walls 440 but also by supporting arms 448 fixed to and projecting forwardly from the side walls 136 and 138 of the main frame. Outwardly beyond the arm 448 which is fixed to the wall 136, the shaft 446 carries a sprocket which meshes with a chain 450. This chain 450 in turn extends around and meshes with a sprocket carried by the main drive shaft 150.

Thus, the drive from the motor 148 is transmitted from the shaft 150 through the chain 450 to the shaft 446 so as to simultaneously rotate all of the bevel gears 444. These gears in turn rotate all of the bevel gears 442, so that the shafts 416 and the rollers 80 therewith, at each unit are all continuously rotated. The roller 80 at each unit drives the pinion 424 which meshes with the gear 428. This latter gear then meshes with the gear 430 so as to transmit the drive to the pinion 426 fixed to the shaft 422 at each unit, so that in this way the roller 82 is simultaneously driven, and of course the rolls 80 and 82 simultaneously rotate equally and oppositely for creasing each sheet and feeding it downwardly into a chute 410 at each unit, each sheet falling through the opening 408, as pointed out above.

GENERAL OPERATION

While there are distinct units 127, 128, 130, and 132, these units of the machine 124 all have components actuated by parts which are common to all of the units.

Thus the base plate **134** is common to all of the units, and the same is true of the supporting bars **140** and **142.** The side frame members **136** and **138** serve in general together with the upper member **280** to carry all of the components together with the base plate **134.** All of the stripping plates **124** and **126** are carried by the common bar **288.** All of the folding plates **98** and **100** are carried by the common bar **258.** The bar **158** carries all of the boxes **152** at the rear walls **156** thereof. The bar **158** carries all of the microswitches of the several sheet-supply means. The suction cups thereof are carried by the common bar **244,** which is in turn carried by only one pair of carriages **200** and **202,** so that this supporting structure is provided for all of the units, and of course it is only the end frame members **136** and **138** which carry the controls for the bar **244.** Thus, the several units of the machine **124** are set up in such a way that components thereof are supported and actuated by common members which not only achieve a convenient and compact arrangement, reducing the structure required by each unit, but which in addition assure full synchronism in the operation of the several units.

During each operating cycle when all of the pleating members are retracted to their rest positions and the inner V-fold means as well as the stripping means are in their upper end positions, the sheet-supply means acts to deliver a sheet at each of the units onto the stationary sheet-supporting portions of the outer V-fold means **90.** Upon retraction of the suction cups back to the stacks of sheets at the boxes, the pair of main cams **270,** which are provided for all of the units, bring about the downward movement of the main control rods **260** and **262,** which also are common to all of the units. This results in the initial folding of the sheets **20** at the several units along the line **22** illustrated in FIG. **15.**

Now the cams **330** and **396** operate to swing the pleating members inwardly to their operative positions, and in this way the side pleats are formed around the pleating plates **116** and **118.**

The fingers **308** of the cams **270** will now bring about downward movement of the stripping plates, and by the time stripping plates have reached the folded sheets to advance the latter to the feed rolls, the cams **396** have returned the outer pleating members **108, 110, 112** and **114** to their outer rest positions, so that the sheet remains pleated but these outer pleating members are at their outer rest positions when the stripper plates operate to strip the sheet from the folding plates. It is during this action that the part **272** of the cam **270** operates to raise the inner V-fold means approximately one-quarter of an inch so as to facilitate the stripping action in this way. The folded sheets are delivered by the stripping members to the feed rolls **80** and **82** which are driven in a manner described above so as to continue the feeding and creasing of the sheets, the inner pleating members **102** and **104** remaining at their operative positions while the sheet **20** is stripped and fed downwardly to the feed rolls at each unit.

Then the inner pleating members and the inner V-fold means return to their initial positions, and of course the movement of the fingers **308** beyond the follower rollers at the bottom ends of the rods **304** and **306** releases the yieldable means **294** so that it can return the stripping members to the positions they normally assume with respect to the inner V-fold means.

It has been found in actual practice that the above-described machine of the invention can operate very rapidly bringing about an output at each unit on the order of 100 folded sheets per minute.

What is claimed is:

1. In a sheet-folding machine, a pair of rolls respectively having parallel axes of rotation and situated adjacent and on opposite sides of a predetermined feed plane situated between and parallel to said axes of rotation for feeding and simultaneously creasing a sheet passing between said rolls along a predetermined feed axis situated in said feed plane, a folding assembly for forming a V-fold in a sheet received between said rolls, said folding assembly being located ahead of said rolls, considered in the direction of sheet travel, and including an outer V-fold means and an inner V-fold means, said outer V-fold means having a pair of spaced sheet-supporting portions provided with oppositely inclined sheet-engaging surfaces which converge toward said rolls and which are situated equidistantly from said feed plane on opposite sides thereof and define between themselves a tapered space through which said feed plane symmetrically extends and across which a sheet initially extends before a V-fold is formed therein, said inner V-fold means being aligned with said space to be received therein for forming a V-fold in a sheet prior to feeding and creasing of the sheet by said rolls, and said inner V-fold means including a pair of folding plates respectively having the same inclination as said sheet-engaging surfaces of said sheet-supporting portions and also defining between themselves a tapered space through which said feed plane symmetrically extends, means operatively connected with one of said V-fold means for advancing it, without changing its inclination, along said feed axis with respect to the other of said V-fold means to situate said inner V-fold means in said space between said sheet-supporting portions to form a V-fold in a sheet, support means supporting said other V-fold means for maintaining the latter V-fold means stationary while said one V-fold means is advanced along said feed axis with respect to said other V-fold means, and a pair of pleating members situated on opposite sides of a pleating plane which is normal to said feed plane and which also contains said feed axis, said pleating members being movable into and out of said space defined between said sheet-engaging surfaces and said pleating members being situated in the latter space at least during part of the time that a sheet is folded by said folding assembly for forming a pair of side pleats between a V-folded sheet portion so that during subsequent feeding and creasing of the sheet by said rolls the sheet will be provided with an outer V-folded portion and with a pair of inner pleats situated between said outer V-folded portion.

2. The combination of claim **1** and wherein a means is operatively connected with said pleating members for moving them simultaneously inwardly toward and outwardly away from said pleating plane.

3. The combination of claim **1** and wherein said means for moving one of said V-fold means is operatively connected with said inner V-fold means for moving the latter into and through said space between said sheet-engaging surfaces toward and in close proximity to said rolls.

4. The combination of claim **3** and wherein a stripper means coacts with said inner V-fold means for stripping

a V-folded sheet therefrom while delivering the thus-folded sheet between said rolls to be fed and creased thereby.

5. The combination of claim **4** and wherein said means operatively connected to said inner V-fold means to move the latter with respect to said outer V-fold means is also operatively connected with said inner V-fold means to retract the latter away from said rolls while said stripper means engages a V-folded sheet, in order to facilitate the stripping action.

6. The combination of claim **1** and wherein a supply means coacts with said outer V-fold means for automatically supplying sheets successively thereto.

7. The combination of claim **1** and wherein said pair of pleating members form a pair of inner pleating members for forming inner pleats between the V-folded sheet portion, and four outer pleating members situated two on one side and two on the other side of said pleating plane for forming in the sheet outer pleats between which inner pleats formed by said inner pleating members are located with all of the pleats being situated between the V-folded sheet portion.

8. The combination of claim **7** and wherein a means is operatively connected with said outer pleating members for moving them through said pleating plane to form in a sheet outer pleats which overlap each other.

9. The combination of claim **7** and wherein said inner V-fold means carries a pair of pleating plates situated on opposite sides of said feed plane symmetrically with respect thereto and extending substantially perpendicularly through said pleating plane, said inner pleating members being situated in said feed plane and said pleating plates being situated between said feed plane and said outer pleating members so that pleats are formed by said pleating members around said pleating plates which are carried by said inner V-fold means.

10. The combination of claim **9** and wherein said pleating plates are located between said folding plates of said inner V-fold means, and stripper means for stripping a folded sheet from said folding plates, said stripper means including stripper plates situated between said pleating plates and folding plates and means connected to said stripper plates for moving the latter toward said rolls for stripping a sheet from said folding plates.

11. The combination of claim **10** and wherein a yieldable means coacts with said inner V-fold means and said stripper plates for normally maintaining the latter at a given position with respect to said inner V-fold means, and said means which moves said stripper plates toward said rolls acting in opposition to said yieldable means.

12. The combination of claim **1** and wherein said pair of folding plates are inclined inwardly toward said feed plane and respectively terminating terminate in substantially pointed ends located adjacent said feed plane so that said pleating members and folding plates form in the V-folded sheet a pair of pointed portions which have tips meeting each other at the crest of the V-folded sheet portion.

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