Jan. 25, 1955 W. J. FOSTER 2,700,327

BELLOWS FOLDING MACHINE

Filed Sept. 6, 1949 6 Sheets-Sheet 1

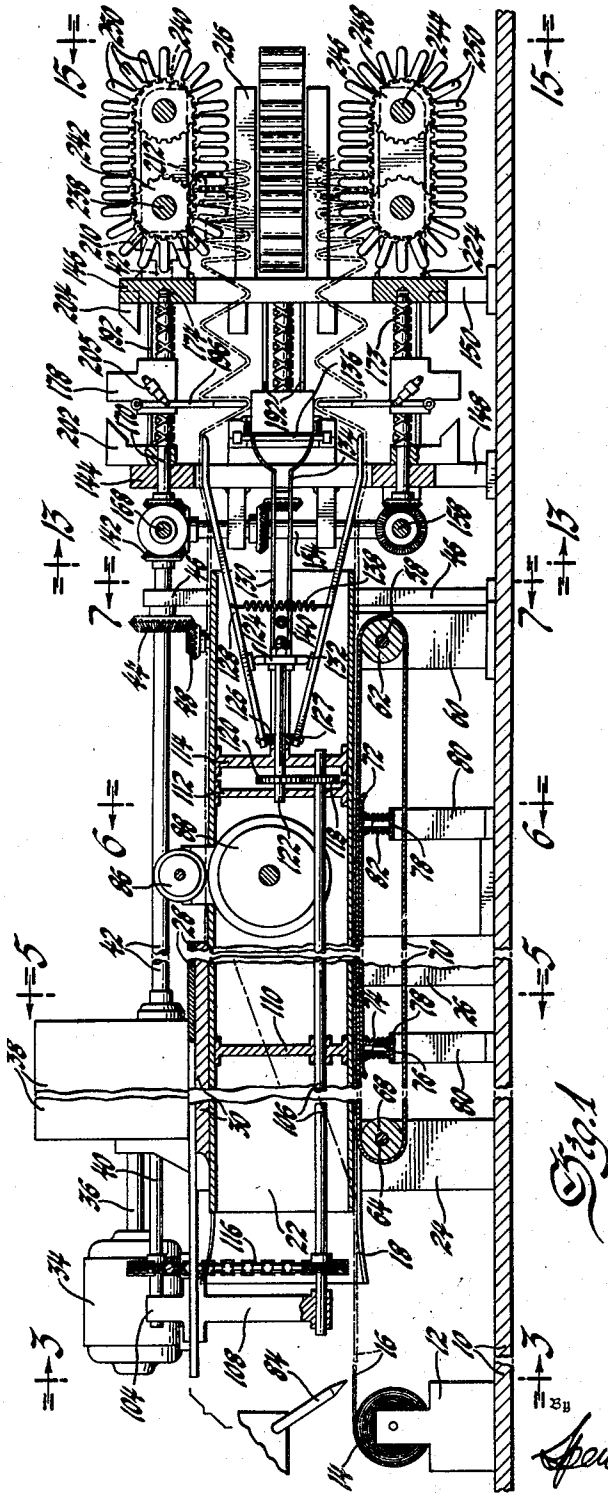


Fig. 1

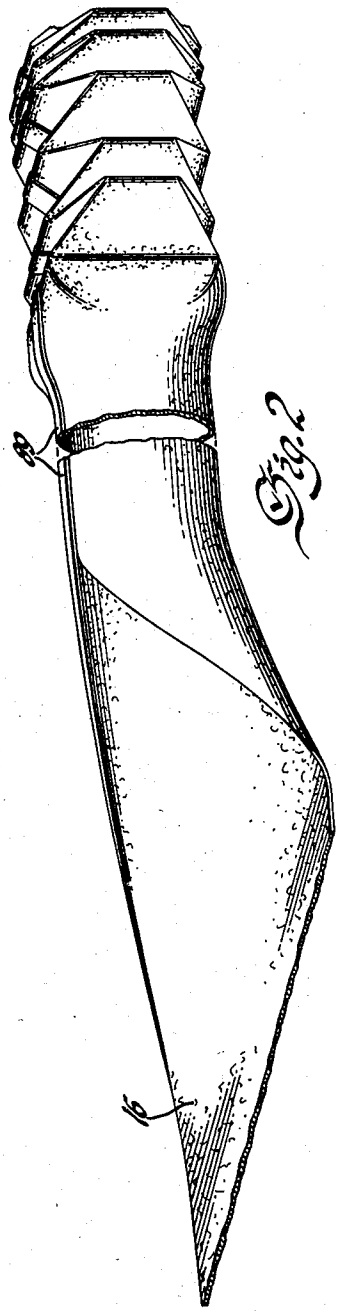


Fig. 2

Inventor
William J. Foster
Spencer, Willis, Helwig & Baillie
Attorneys

Jan. 25, 1955 W. J. FOSTER 2,700,327

BELLOWS FOLDING MACHINE

Filed Sept. 6, 1949 6 Sheets-Sheet 2

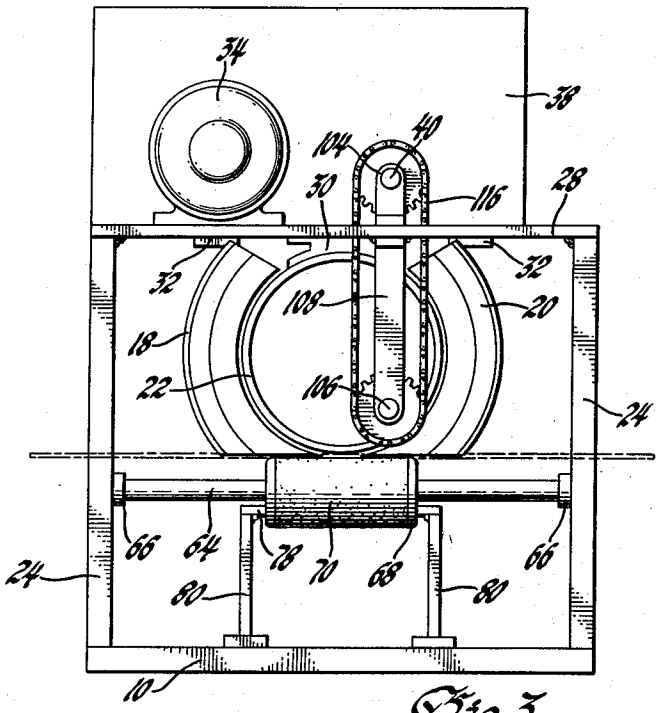


Fig. 3

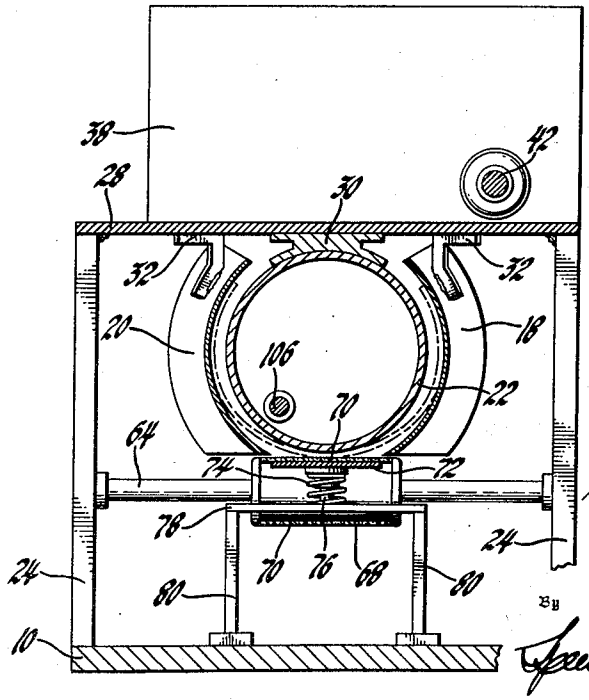


Fig. 5

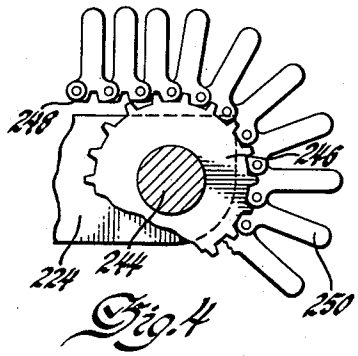


Fig. 4

Inventor
William J. Foster

By
Spencer, Willis, Helwig & Bailey
Attorneys

Jan. 25, 1955 W. J. FOSTER 2,700,327

BELLOWS FOLDING MACHINE

Filed Sept. 6, 1949 6 Sheets-Sheet 3

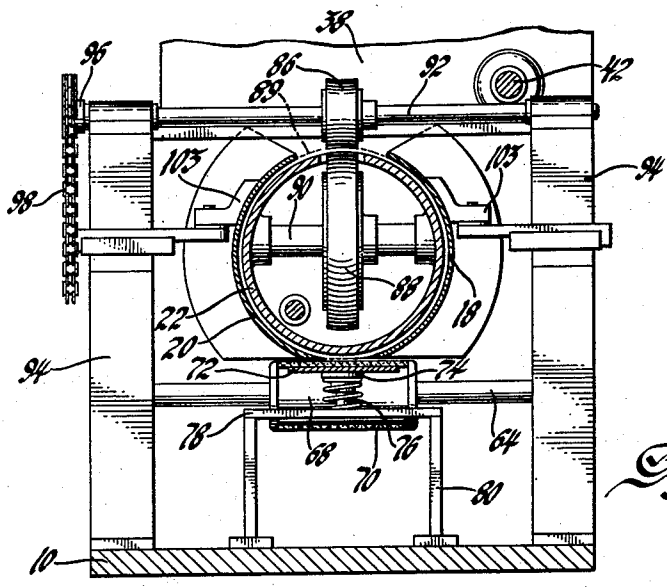


Fig. 6

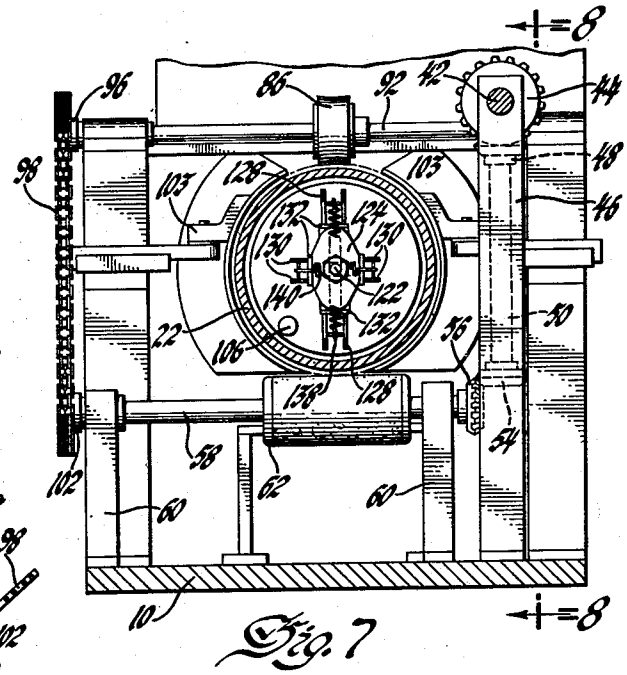


Fig. 7

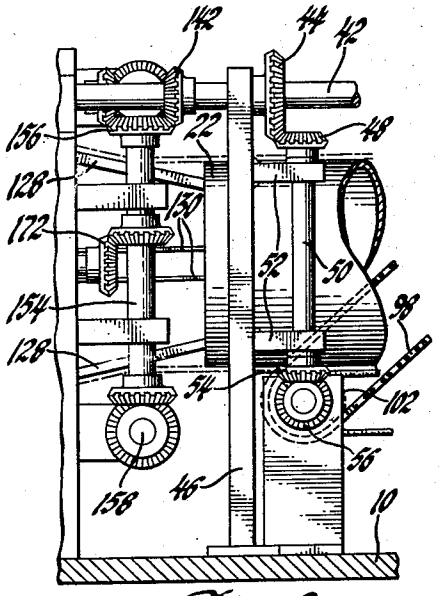


Fig. 8

Inventor
William J. Foster

By Spencer, Wilkes, Helwig & Baillio
Attorneys

Jan. 25, 1955 W. J. FOSTER 2,700,327

BELLOWS FOLDING MACHINE

Filed Sept. 6, 1949 6 Sheets-Sheet 4

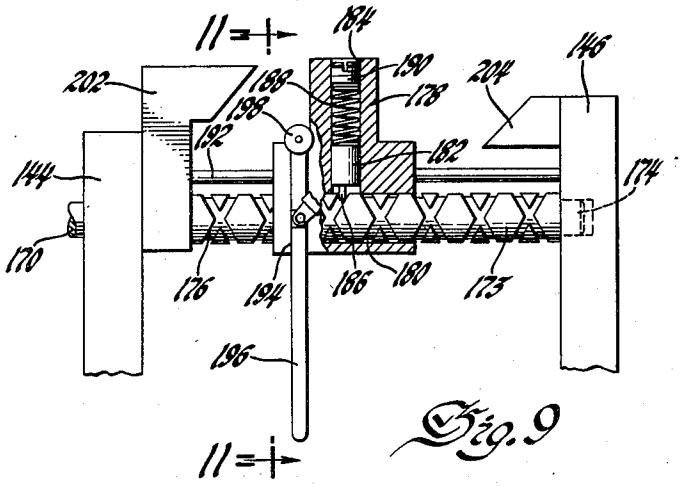


Fig. 9

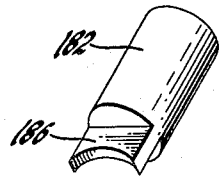


Fig. 10

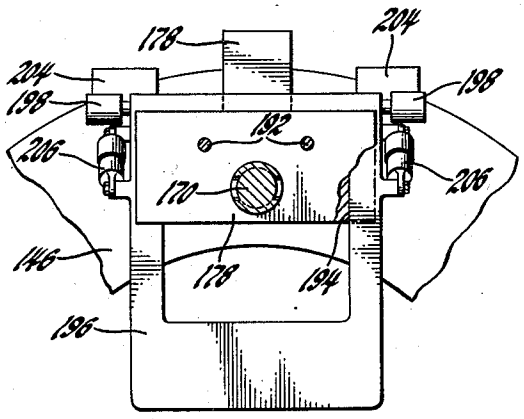


Fig. 11

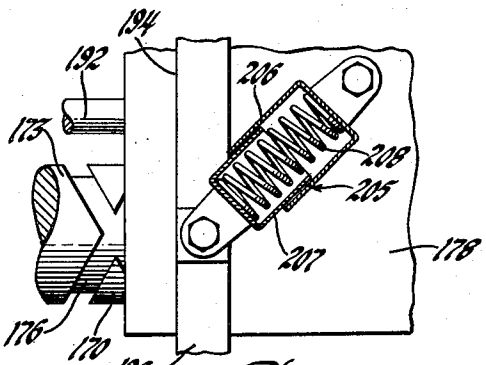


Fig. 12

Inventor
William J. Foster
By
Spencer, Wilkes, Delaney & Baillio
Attorneys

Jan. 25, 1955 W. J. FOSTER 2,700,327

BELLOWS FOLDING MACHINE

Filed Sept. 6, 1949 6 Sheets-Sheet 5

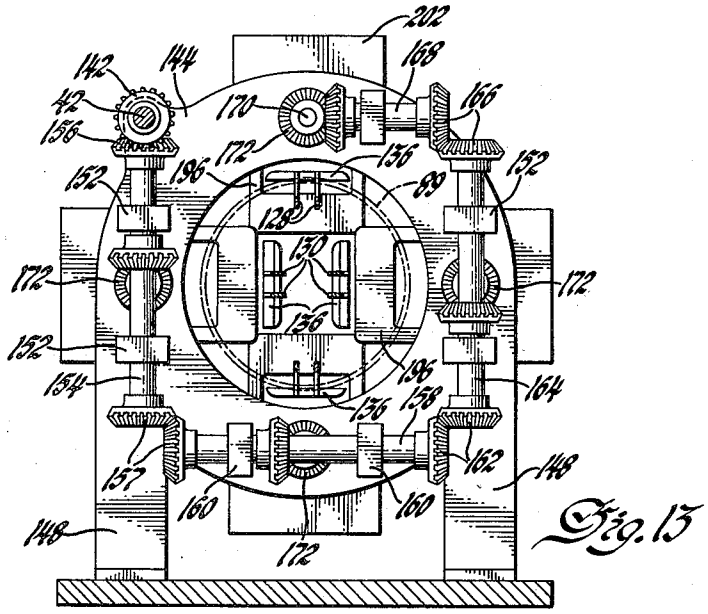


Fig. 13

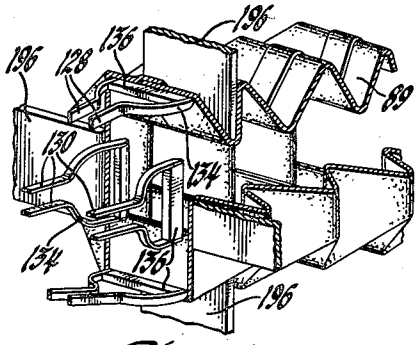


Fig. 14

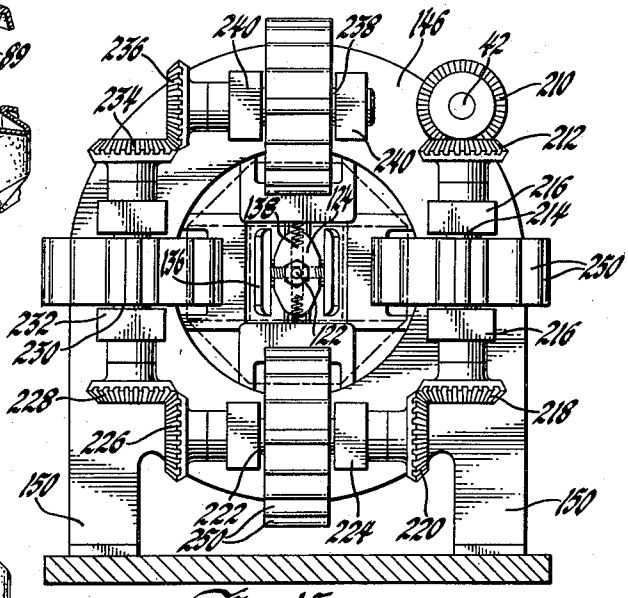


Fig. 15

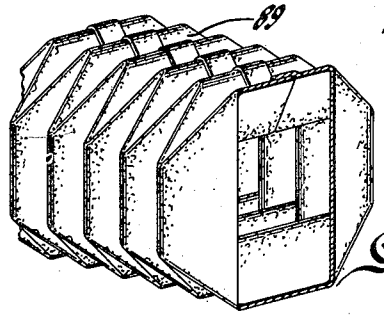


Fig. 16

Inventor
William J. Foster
By
Spencer, Willis, Helwig & Baillio
Attorneys

Jan. 25, 1955 W. J. FOSTER 2,700,327

BELLOWS FOLDING MACHINE

Filed Sept. 6, 1949 6 Sheets-Sheet 6

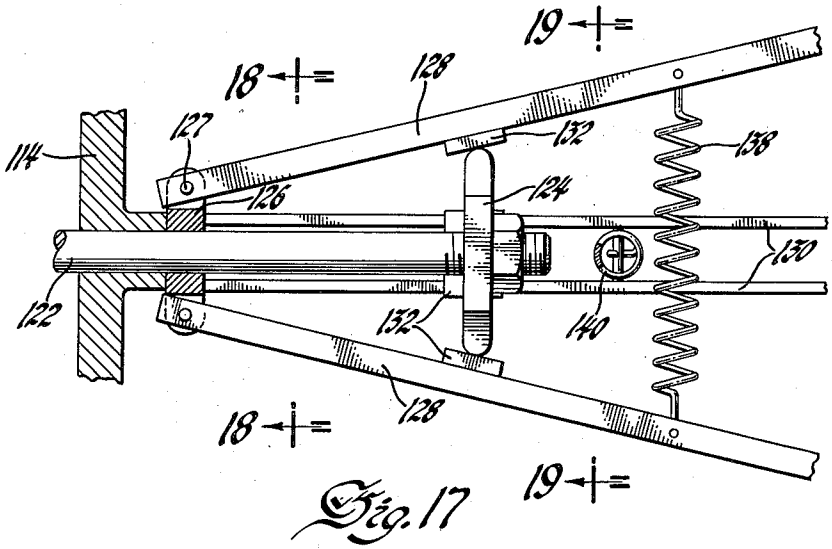


Fig. 17

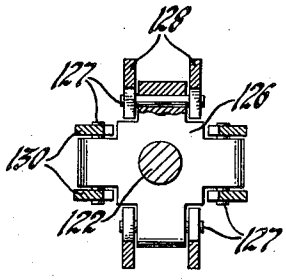


Fig. 18

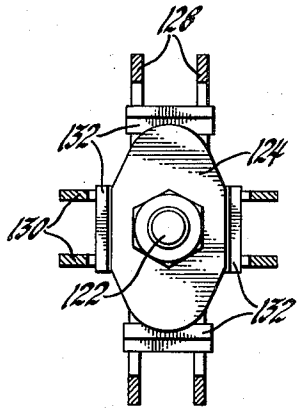


Fig. 19

Inventor
William J. Foster

By
Spencer, Willits, Helwig & Baillie
Attorneys

United States Patent Office 2,700,327 Patented Jan. 25, 1955

2,700,327

BELLOWS FOLDING MACHINE

William J. Foster, Harpenden, England, assignor to General Motors Corporation, Detroit, Mich., a corporation of Delaware

Application September 12, 1949, Serial No. 115,177

33 Claims. (Cl. 93—1)

This invention relates to a paper folding machine and more particularly to a continuous bellows folding machine.

The folding machine takes the paper stock in the form of an elongated strip from a roll and by passing the paper between two cylindrical formers progressively folds the paper into a tube. Suitable sealing means unites the paper joint between the edges of the paper strip. Then internal and external formers located in the vertical plane simultaneously form a vertically elongated pleat in the paper tube. The vertical external formers then move the paper along so that horizontal internal and external formers may form the next pleat, which is elongated in the horizontal plane at right angles to the elongation of the first pleat. The horizontal external formers then move the paper tube along to the position for the vertical internal and external formers to form the next pleat which is elongated in the vertical plane. The external formers and feeders release the paper pleats just before the creasing paddles which grip each pleat to hold and set the crease.

The object of the invention is to provide a continuous bellows folding machine which continuously forms a strip of sheet material into a tube, and then forms pleats in the tube to continuously form an angularly pleated bellows.

Another object of the invention is to provide a continuous bellows forming machine having formers which consecutively form in a paper tube a series of pleats alternately extending vertically and horizontally and having paddles which firmly set the creases or folds of the pleats.

Another object of the invention is to provide in a bellows folding machine an inner and an outer pair of tube forming guides which form the paper tube about the internal pleat formers of the bellows folding machine.

These and other objects of the invention will be apparent from the following drawings and specification.

Figure 1 is a partial elevation view of the bellows forming machine with parts in section.

Figure 2 is a partial perspective view of the paper stock showing the progressive stages in the formation of the bellows.

Figure 3 is a cross section of Figure 1 on the line 3—3.

Figure 4 is a partial detail view of the crease setters.

Figure 5 is a partial sectional view of Figure 1 on the line 5—5.

Figure 6 is a partial sectional view of Figure 1 on the line 6—6.

Figure 7 is a partial sectional view of Figure 1 on the line 7—7.

Figure 8 is a partial sectional view of Figure 7 on line 8—8.

Figure 9 is a partial detail view of the feeding mechanism with parts in section.

Figure 10 is an enlarged perspective view of the thread follower.

Figure 11 is a sectional view with parts in section of Figure 9 on line 11—11.

Figure 12 is a fragmentary enlargement of a portion of Figure 9 showing the compression spring.

Figure 13 is a cross section of Figure 1 on the line 13—13.

Figure 14 is a partial perspective view with parts in section showing the internal and external pleat formers acting on the paper tube.

Figure 15 is a sectional view of Figure 1 on the line 15—15.

Figure 16 is a partial perspective view showing a short section of the bellows folded by this machine.

Figure 17 is an enlarged partial view of the internal former mounting.

Figure 18 is a section of Figure 17 on the line 18—18 with parts broken away.

Figure 19 is a section of Figure 17 on the line 19—19.

The bellows forming machine is mounted on a suitable support or base 10. A suitable stanchion 12 mounted on the base and having a transverse rod supports the roll of paper stock 14. A ribbon or strip 16 of paper stock material is fed from the roll 14 through the machine. The strip material first engages the flared or funnel-like ends of the exterior semi-cylindrical formers 18 and 20. Referring to Figure 3, it will be noticed that these formers are cut away at the top and bottom to provide a rather wide space between their meeting edges. The cylindrical internal former 22 or mandrel is located within the external formers to provide an internal guide and form upon which the paper tube is made. A supporting frame consisting of a rear pair of supporting posts 24 and a front pair of supporting posts 26 is suitably secured to the base 10 by means such as welding, and a plate 28 secured to the top of the posts and positioned just above the internal and external tube formers. A bracket 30 is secured to the under side of the plate 28 and the upper portion of the internal tube former 22. It will be noted that this bracket 30 provides the sole support for the internal tube former 22, and that the former extends forwardly in the nature of a cantilever beam. The external formers 18 and 20, which are spaced apart at the top to provide room for the bracket 30, are also secured to the under side of plate 28 by brackets 32. The exterior tube formers 18 and 20 have a wide open mouth at the front end and are widely spaced from the interior cylindrical tube former. However, the exterior tube formers narrow down to substantially the same size as the internal cylindrical former progressively in the direction of movement of the paper or toward the forward end of the machine. The sectional views 3, 5, 6 and 7 clearly show this progressive reduction in the diameter of the external tube formers.

The supporting plate 28 extends rearwardly of the posts 24 to provide a base for the electric motor 34 which drives the machine. The motor is connected by shaft 36 to suitable reduction gearing mounted on the plate 28 and positioned within the housing 38. All the components of the machine are driven by the shaft 40 which extends reawardly from the gear housing and by the shaft 42 which extends forward from the gear housing on the left side of the machine to the front of the machine, as shown in Figure 1.

The gear 44 mounted on shaft 42 adjacent the support 46 provides the power take-off mechanism for the endless belt feeding device located beneath the cylindrical formers. The bevel gear 44 meshes with the gear 48 mounted on the upper end of the vertical transverse shaft 50, which is best shown in Figures 7 and 8. The vertical shaft 50 is mounted by brackets 52 attached to the side of the support 46 which is secured to the base 10. At the lower end of the vertical shaft the bevel gear 54 meshes with the bevel gear 56 mounted on the end of the horizontal roller shaft 58, which is supported at opposite ends in the bearing posts 60 which are suitably secured to the base plate 10. A pulley 62 is secured to the shaft 58 centrally beneath the cylindrical former 22. At the rear end of the machine a horizontal pulley shaft 64 is suitably mounted in bearings 66 attached to the inside of the pair of posts 24. A rear pulley 68 is mounted on the horizontal shaft 64. The pulleys 62 and 68 which are horizontally positioned centrally beneath the cylindrical former 22 support an endless belt 70 which contacts and feeds the paper strip material through the machine as best shown in Figure 1. In order to maintain an even pressure of the belt against the paper strip material an elongated shoe 72 is mounted beneath the upper reach of belt 70. Shoe 72 has two or more spring-pressed supports consisting of a hollow cy-

lindrical bushing 74 secured to the under side of the shoe 72. A pin 76 is slidably mounted within the hollow bushing and secured to a horizontal support 78 which extends between both reaches of the endless belt 70. The ends of the support 78 which extend beyond the sides of the belt are secured to suitable posts 80 which are supported and secured to the base 10. A suitable coil spring is positioned between the horizontal support 78 and around the cylindrical bushing 74 in order to resiliently maintain the shoe in contact with the belt. It will be noted that the semi-cylindrical formers 18 and 20 are bevelled off horizontally at the bottom so that they do not interfere with the belt 70.

As the paper strip material leaves the roll a suitable glue applicator 84 applies a thin ribbon of glue to the upper surface of the paper strip adjacent one edge. As the paper strip material progresses into the funnel-like end of the formers 18 and 20, the edges are folded up and around the central cylindrical former 22 as shown in dotted lines in Figure 1, or as shown by the perspective view in Figure 2. When the edges of the paper strip meet at the top of the former to form a joint, the joint passes between sealing roller 86 and idler 88 to compress and seal the joint to form a tube 89. As best illustrated in Figure 6 the idler 88 is mounted on the shaft 90 supported by suitable bearings 91 secured to the inner surface of the cylindrical former 22. The driven sealing roller 86 is fixed to a horizontal shaft 92 suitably supported in bearings at the upper ends of supporting posts 94 secured on opposite sides of the base. One end of the shaft 92 extends outboard of the right post 94 and has a sprocket wheel 96 which is driven by a chain 98 from the sprocket wheel 102 mounted below on the outboard end of the forward pulley shaft 58. Additional support for the outer tube formers 18 and 20 is provided by the brackets 103 secured to the posts 94. The paper is now sealed in the form of a tube and continuously moves along between the interior cylindrical former 22 and the exterior semi-cylindrical formers 18 and 20 which closely surround the interior former at this portion of the machine.

The internal pleat formers are actuated from the shaft 40 which extends rearwardly from the gear-box 38 to a bearing support 104 fixed to the plate 28. A shaft 106 extending through the lower portion of the cylindrical former 22 is supported by bearing bracket 108 mounted on the under side of plate 28 and a plurality of circular bulkheads 110, 112 and 114, and is driven by the sprockets secured to each shaft and the chain 116 running on the sprockets. At the forward end of the cylindrical former 22, where the shaft 106 is closely supported by bulkheads 112 and 114, a gear 188 is fixed to the shaft 106. The gear 118 drives gear 120 which is mounted on shaft 122. The cam shaft 122 is centrally supported in the former 22 by the bulkheads 112 and 114 and has at its outboard end a two-lobe cam 124. The forward bulkhead 114 has a forwardly extending bracket 126 surrounding the shaft 122. The bracket 126 provides anchorage for four pintle pins 127 disposed as the sides of a square, as best shown in Figures 17 and 18. On the upper and lower pintle pins the pair of vertical tube formers 128 are pivoted. On the side pair of pintle pins the horizontal pleat formers 130 are pivoted. As best shown in Figures 1, 17 and 19 of the drawings the vertical and horizontal formers are in the form of a U-shaped metal strip with a cam pad 132 secured to the legs of the U intermediate their ends to provide a pad for the cam 124 to act upon. At the base of the U where the formers engage the paper tube to form the pleats, the legs are spread apart in a stirrup shape 134 and have a plate end or base bar 136. A tension spring 138 connected between the vertical pleat formers 128 and a similar coil spring 140, connected between the horizontal formers 130, resiliently maintains the pad 132 on each former in contact with the cam.

The shaft 42 extends beyond the gear 44 and through the supporting post 46, which provides a bearing support to drive the gear 142, which drives the external formers and feed mechanism. The external formers are mounted between a rear annular ring 144 and a forward annular ring 146. The ring 144 is supported by feet 148 which are made integral with or riveted or welded to the ring. Similar feet 150 support the forward ring 146. As best shown in Figure 13, the rear ring 144 has brackets 152 suitably supporting and providing a bearing for a vertical shaft 154 which has a bevel gear 156 at the upper end driven by gear 142. The vertical shaft 154 is connected by suitable bevel gears 157 to a horizontal shaft 158 similarly supported in brackets 160 mounted on the ring 144. Similar suitable bevel gears 162 mounted on the other end of horizontal shaft 158 and the lower end of the other vertical shaft 164 provide the drive for this vertical shaft, which is rotatably mounted in brackets 165. The bevel gears 166 between the upper end of the vertical shaft 164 which is supported by bracket 167 and the top horizontal shaft 168, provide an interconnection so that the four exterior former shafts 170 and their gears 172 may all be driven at the same speed. It will be noted that the exterior former shafts 170 are located in opposed pairs on the vertical and horizontal axes of the cylindrical former when the internal formers move on these axes. Each of the shafts 170 has a bearing supported in the ring 144 and extending forwardly for bearing support in the bearing 174 (Figure 1) in the forward ring 146 and a central enlarged portion 173 with a two-way thread 176. As best shown in Figure 9, a carriage 178 having a bore 180 is mounted for reciprocation upon the shaft 170, and has a thread follower 182 slidably mounted in a transverse bore 184 transversely arranged with respect to the bore 180. The thread follower has a tongue 186 with an arcuate end as best shown in Figure 10, to seat in the thread 176. The follower 182 is maintained in contact with the thread 176 by the spring 188 which is held in the transverse bore 184 by a plug 190.

In order to prevent rotation of the carriage 178 two guide rods 192, which extend through guide bores in the carriage 178 on opposite sides of the bore 180 are secured to the support rings 144 and 146. A pair of opposed grooves 194 are positioned on opposite sides of the carriage 178 to receive and guide the exterior formers 196. The formers 196 have a rectangular frame shape with opposed inner edges slidably mounted in the grooves 194. A pair of rollers 198 is secured to the former 196 adjacent the outer end thereof and arranged to contact an inwardly actuating cam 202 adjacent the rear edge of the end of the former travel, and an outwardly actuating cam 204 adjacent the forward edge of the former travel. The cam 202 is supported by suitably securing it to the ring 144 and the cam 204 is secured to the ring 146. These cams merely have flat inclined planes which contact the rollers on the end of the formers to move the former either inward or outward. A compression spring 205 is pivotally connected between the carriage 178 and the sliding former 196 to resiliently hold the former in either the inner position or the outer position. In order to maintain the spring in alignment between the pivot points a telescopic housing consisting of an outer sleeve 206 having an ear pivotally mounted by a screw on the carriage and an inner sleeve 207 having an ear pivotally mounted by a screw on the former. A coil spring 208 is positioned within the telescopic housing.

The main drive shaft 42 extends forward and is supported by the bearing in the rings 144 and 146. A gear 210 is mounted on the outboard end of the shaft 42 forward of the ring 146, and drives a gear 212 on the upward end of shaft 214 which is suitably supported in brackets 216 on the ring 146. A gear 218 on the lower end of shaft 214 meshes with the gear 220 on the horizontal shaft 222 which is supported on the ring 146 by brackets 224. The other end of shaft 222 has a gear 226 meshing with gear 228 on the lower end of the vertical shaft 230 which is supported by brackets 232 on the ring 146. The upper end of shaft 230 is connected by gears 234 and 236 to the upper horizontal shaft 238 which is supported in brackets 240 on the ring 146. Thus the gear 210 drives a pair of vertical shafts 214 and 230 and a pair of horizontal shafts 222 and 238 at the same speed. As best shown in Figure 1 a pair of sprocket wheels or one wide sprocket wheel 242 is mounted on each of these shafts and centered about the horizontal and vertical axes to the cylindrical former 22. The pairs of brackets 216, 224, 232 and 240 extend forwardly to support an idler shaft 244 which supports a sprocket wheel 246. An endless chain 248 is mounted on the sprocket wheels 242 and 246. Each of the links of the chain 248 has an elongated finger or plate 250 extending radially outward from the surface of the chain link. As shown in Figure 4 the outer ends of the fingers 250 separate as the chain moves around the sprocket wheel and move together as the chain starts to move through the straight reach portion of its travel.

In the operation of the machine the flat paper ribbon or elongated sheet is fed from the roll 14. After glue is applied in a thin strip along one edge the paper is fed between the cylindrical former 22 and the outer formers 18 and 20. The outer formers progressively reduce the diameter of the paper strip until the edges thereof are brought together at the top center of the cylindrical former and the tube 89 thus formed is closely confined to the cylindrical former by the outer formers. Then the meeting edges of the paper tube with the glue therebetween pass between the driven seal roller 86 and the idler wheel 88, to seal the paper in the form of a tube 89. The strip of material or tube is progressively moved by the belt 70. When the paper tube leaves the cylindrical formers and is first acted upon by one of the opposed pairs of internal pleat formers in conjunction with its coacting external formers as shown in Figure 1 and Figure 11, the vertical pair of pleat formers is shown in the expanded position necessary to form a vertical elongated pleat. The external vertical pleat formers are shown acting in conjunction with the internal pleat formers to hold the previously formed pleat in shape and to move the blank along for the formation of the next pleat. When this pleat is formed the vertical internal pleat formers move together and the external vertical formers move forward to make room for the external horizontal pleat formers which will then move in and grip the paper in the same way, and work in conjunction with the horizontal internal pleat formers. Thus successive horizontal and vertical pleats are formed in the paper tube. The pleated paper tube or bellows then moves forward and is caught between the tongues 250 on the chains 248. The tongues are spread apart at the rear end of their travel and allow the pleats to extend therebetween. When the tongues travel in a straight line for a short portion they move together to squeeze a sharp fold in each pleat. Thus the continuous bellows is formed and passes out of the machine where it may be cut in suitable lengths for any desired use.

It will be understood from the foregoing description that the invention is not concerned with the specific horizontal and vertical position but rather with relative right angle relationship of the parts of the machine. However, the terms horizontal and vertical have been used for convenience in referring to and identifying the parts located in horizontal and vertical positions of the preferred embodiment of the invention illustrated in the drawing. The machine may be operated in any position such as other horizontal positions resting on another side thereof or a vertical position resting on an end. Thus it will be appreciated that these terms are used to conveniently describe the substantially right angular relationship between these parts.

The above specific embodiment of the machine is illustrative of the invention. Numerous modifications will be apparent to those skilled in the art within the terms of the appended claims.

I claim:

1. In a bellows folding machine, a support, means mounted on said support to guide a tubular blank along a longitudinal axis of the tubular blank, internal formers having portions engageable with the inside of the tubular blank and being mounted on said support adjacent said axis and within the tubular blank for substantially planar radial outward movement of said portions into engagement with the inside of the tubular blank to form the blank, the portions of said internal formers being fixed against longitudinal movement relative to said axis, and external formers mounted on said support about said axis and externally of the tubular blank for radial inward movement to contact the outside of the tubular blank to form the blank, and means to move said internal and external formers to form the blank.

2. In a bellows folding machine, a support, guide means mounted on said support to guide a tubular blank along a longitudinal axis of the tubular blank, internal formers having portions engageable with the inside of the tubular blank and being mounted on said guide means adjacent said axis and within the tubular blank for substantially planar radial outward movement of said portions into engagement with the inside of the tubular blank to form the tubular blank, the portions of said internal formers being fixed against longitudinal movement relative to said axis, and external formers mounted on said support about said axis and externally of the tubular blank for radial inward movement to contact the outside of the tubular blank to form the blank, and means to move said internal and external formers to form the blank.

3. In a bellows folding machine, a support, means mounted on said support having a surface to guide a tubular blank along a longitudinal axis of the tubular blank, internal formers mounted on said support adjacent said axis and within the tubular blank for substantially radial outward movement toward the surface of said guide means to contact the inside of the tubular blank and for return movement, external formers mounted on said support about said axis and externally of the tubular blank for substantially planar radial inward movement toward the surface of said guide means to contact the outside of the tubular blank and for return movement, and means to move said internal and external formers to cooperate to form bellows pleats.

4. In a bellows folding machine, a support having an axis, means on said support to guide a tubular blank on said axis, internal formers having portions engageable with the inside of the tubular blank and being pivotally mounted on a long lever arm on said support within the tubular blank for substantially planar radial outward movement of said portions from adjacent said axis into engagement with the inside surface of the tubular blank, the portions of said internal formers being fixed against longitudinal movement relative to said axis external formers mounted on said support further from said axis than said internal formers and externally of the tubular blank for radial and longitudinal movement to contact the outside surface of the tubular blank, and means to move said internal and external formers to form pleats.

5. In a bellows folding machine, a support having an axis, means on said support to guide a tubular blank on said axis, internal formers pivotally mounted on said support within the tubular blank for outward movement from an initial position adjacent said axis to contact the inside surface of the tubular blank and return movement to said initial position, and external formers mounted on said support externally of the tubular blank for substantially planar radial inward movement from a position spaced further from said axis than said position of said internal formers and longitudinal movement to contact the outside surface of the tubular blank and return movement to said initial position of the external formers, means to move said internal and external formers to form pleats.

6. In a bellows folding machine, a support having an axis, means on said support to guide a tubular blank coaxially along said axis, internal formers having portions engageable with the inside of the tubular blank and being pivotally mounted on said support within the tubular blank for substantially planar radial outward movement of said portions from a position adjacent said axis into engagement with the inside surface of the tubular blank and for return movement, the portions of said internal formers being fixed against longitudinal movement relative to said axis, external formers mounted on said support externally of the tubular blank for inward movement from a position spaced further from said axis than said position of said internal formers and for longitudinal movement to contact the outside surface of the tubular blank and for return movement, and means to move said internal and external formers to form pleats.

7. In a folding machine, a support having an axis, fixed guide means mounted on said support about said axis to guide a tubular blank coaxially along said axis, means to move the tubular blank axially past the fixed guide means, internal formers having portions engageable with the inside of the tubular blank and being mounted on said support within the tubular blank for substantially planar radial outward and inward movement of said portions with respect to said axis and located adjacent said axis, the portions of said internal formers being fixed against longitudinal movement relative to said axis external formers mounted on said support externally of the tubular blank for inward and outward and longitudinal movement with respect to said axis and located further from said axis than said internal formers, and means to move said internal formers outwardly to contact the inside of a tubular blank and to cooperatively move said external formers inwardly and lon-

gitudinally to contact the outside of a tube blank to form pleats.

8. In a folding machine, a support having an axis, fixed guide means mounted on said support about said axis to guide a tubular blank coaxially along said axis, means to move the tubular blank axially past said fixed guide means, internal formers mounted on said support within the tubular blank for outward and inward movement with respect to said axis and located adjacent said axis, external formers mounted on said support externally of the tubular blank for substantially planar radial inward and outward and longitudinal movement with respect to said axis and located further from said axis than said internal formers, and means to move said internal formers outwardly to contact the inside of a pleat portion of a tubular blank and to cooperatively move said external formers inwardly and longitudinally to contact the outside of the same pleat portion of a tube blank to form a pleat.

9. In a folding machine, a support having a ring-like folding station and an axis extending through said ring-like folding station, means mounted on said support to guide a tubular blank in said folding station, internal formers located within said folding station and mounted on said support for outward movement from adjacent said axis to said folding station and return movement, external formers located outside of said folding station and mounted on said support for substantially planar radial inward movement to said folding station, and means to cooperatively move said internal formers outwardly and said external formers inwardly to form a pleat in a tubular blank.

10. In a folding machine, a support having a ring-like folding station and an axis extending through the center of said ring-like folding station, means mounted on said support to guide a tubular blank to said folding station, means on said support to move the blank in one direction coaxially through said folding station, internal formers having portions engageable with the inside of the tubular blank and being located within said folding station and mounted on said support for substantially planar radial outward movement of said portions from adjacent said axis to said folding station and return movement the portions of said internal formers being fixed against longitudinal movement relative to said axis, external formers located outside of said folding station and mounted on said support for inward movement to said folding station and for longitudinal movement axially in said one direction and return movement and, means to cooperatively move said internal formers outwardly and said external formers inwardly and longitudinally to engage the same pleat portion of the tubular blank to form a pleat in a tubular blank and means to return said internal and said external formers.

11. In a folding machine, a support having a ring-like folding station and an axis extending centrally through said folding station, means on said support to position a tubular blank in said folding station, a pair of vertical internal formers and a pair of horizontal internal formers mounted on said support within said folding station adjacent said axis for outward movement from said axis substantially in a radial plane to said folding station and return movement, a pair of vertical external formers and a pair of horizontal external formers mounted on said support outside of said folding station for inward movement substantially in a radial plane to said folding station and for longitudinal movement with respect to said axis and return movement, means to cooperatively move said horizontal internal formers and said horizontal external formers to said folding station to form pleats and means to cooperatively move said vertical internal formers and said vertical external formers to said folding station to form pleats.

12. In a folding machine, a support having a tubular folding station coaxially located on the longitudinal axis of the machine, means mounted on said support to guide a tubular blank in said tubular folding station, means on said support to continuously move the tubular blank longitudinally along said axis and through said tubular folding station, internal formers located within said tubular folding station and mounted on said support for outward movement substantially in a radial plane to said tubular folding station to contact the inside of the moving tubular blank, external formers located externally of said tubular folding station and mounted on said support for inward movement substantially in a radial plane to said tubular folding station to contact the external surface of the moving tubular blank, means connected to said formers to move said internal formers outwardly to said tubular folding station and said external folders inwardly to said tubular folding station to cooperatively engage the same pleat portion of the moving tubular blank to form a pleat.

13. In a folding machine, a support having a tubular folding station coaxially located on the longitudinal axis of the machine, means mounted on said support to guide a tubular blank in said tubular folding station, means on said support to continuously move the tubular blank longitudinally along said axis and through said tubular folding station, internal formers located within said tubular folding station and mounted on said support for outward movement substantially in a radial plane to said tubular folding station to contact the inside of the moving tubular blank, external formers located externally of said tubular folding station and mounted on said support for substantially planar radial inward movement to said tubular folding station to contact the external surface of the moving tubular blank and for longitudinal movement in said tubular folding station with said tubular blank, means connected to said formers to move said internal formers outwardly to said tubular folding station and said external folders inwardly to said tubular folding station to cooperatively engage the same pleat portion of the moving tubular blank to form pleats, means connected to said formers to withdraw said internal and external formers, and additional means having compressing members mounted on said support for movement with the moving tubular blank to receive the pleats formed by said formers to engage and compress the pleats to set the creases.

14. In a folding machine, a support having a tubular folding station, means to guide a tubular blank at said tubular folding station, internal formers pivotally mounted on said support and located within said tubular folding station for outward movement to said tubular folding station to contact the inside of a tubular blank, cam means mounted on said support to engage and move said internal formers outwardly, external formers mounted on said support and located externally of said tubular folding station for substantially radial inward movement to said tubular folding station to contact the outside of the tubular blank to coact with said internal formers to form a pleat and for longitudinal movement axially through said tubular folding station to move the pleat from said folding station, means on said support to move said external formers radially and longitudinally, and means mounted on said support adjacent said tubular folding station to compress the pleats to set the crease of the pleats.

15. In a folding machine, a support having a tubular folding station on the longitudinal axis of the machine, means mounted on said support to guide a tubular blank in said tubular folding station, means on said support to continuously move the tubular blank longitudinally along said axis and through said tubular folding station, internal formers located within said tubular folding station and mounted on said support for outward movement to said tubular folding station to contact the inside of the moving tubular blank, external formers located externally of said tubular folding station and mounted on said support for radial inward movement to said tubular folding station to contact the external surface of the moving tubular blank and for longitudinal movement in said tubular folding station with said tubular blank, cam means connected to said formers to move said internal formers outwardly to said tubular folding station to engage the inside of said moving tubular blank and to withdraw said internal formers, two-way screw and cam means connected to said external folders to move said external folders inwardly to said tubular folding station in cooperation with said internal formers to engage the moving tubular blank to form pleats and to return said external formers, and means mounted on said support for movement with the moving tubular blank and to engage and compress the pleats formed by said formers to set the creases.

16. In a folding machine, a support having a tubular folding station on the longitudinal axis of the machine, means mounted on said support to guide a tubular blank in said tubular folding station, internal formers located within said tubular folding station and mounted on said support for outward movement to said tubular folding

station to contact the inside of the tubular blank, external formers located externally of said tubular folding station and mounted on said support for radial inward movement to said tubular folding station to contact the external surface of the tubular blank and for longitudinal movement in said tubular folding station, cam means connected to said formers to move said internal formers outwardly to said tubular folding station to contact the internal surface of the tubular blank and to return said internal formers, cam and screw means connected to said external formers to move said external folders inwardly to said tubular folding station to engage the outside tubular blank in cooperation with said internal formers to form pleats and to return said external formers, and means mounted on said support for movement to engage and compress the pleats formed by said formers to set the creases.

17. In a folding machine, a support having a first and a second station, means mounted on said support to guide a tubular blank through said first and second stations, forming means mounted on said support at said first station to form folds in said blank, separate crease setting means mounted on said support at said second station to receive the fold formed by said forming means at said first station and to compress and crease the fold, said crease setting means having a pair of spaced parts, endless means rotatably mounted on said parts, and a series of radial members attached to said endless means extending radially outward from said endless means, and means including a portion of said forming means to move said blank longitudinally from said forming means at said first station to said crease setting means at said second station.

18. In a folding machine, a support having a tubular folding station and a crease setting station, means mounted on said support to support a tubular blank at said tubular folding station, internal formers movably mounted on said support within said tubular folding station, external formers movably mounted on said support externally of said tubular folding station for movement inwardly to said tubular folding station and longitudinally in said tubular folding station, means to move said internal formers outwardly toward said tubular folding station and said external formers inwardly toward said tubular folding station to cooperate together to pleat a tubular blank positioned at said tubular folding station, means to move said external formers longitudinally to move the tubular blank from said tubular folding station toward said crease setting station and means mounted on said support at said crease setting station for movement longitudinally with the blank to engage and compress the pleats to set the crease of the pleats formed at said folding station as the blank passes through said crease setting station.

19. In a folding machine, a support having a tubular folding station and a crease setting station, means mounted on said support to support a tubular blank at said tubular folding station, internal formers movably mounted on said support within said tubular folding station, external formers movably mounted on said support externally of said tubular folding station for movement in a rectangular path, means to move said internal formers outwardly toward said tubular folding station and said external formers inwardly toward said tubular folding station to cooperate together to pleat a pleat portion of a tubular blank positioned at said tubular folding station, means to move said external formers longitudinally to move the tubular blank from said tubular folding station toward said crease setting station, and means located at said crease setting station and mounted on said support for longitudinal movement with the blank to compress the pleats to set the crease of the pleats as the blank passes through said crease setting station.

20. In a folding machine, a support, guide means mounted on said support to guide a tubular blank, former means mounted on said support for movement to engage a tubular blank to form pleats in the tubular blank, actuating means connected to said former means to move said former means to engage the tubular blank to form a pleat and to retract said former means, setting means having pleat engaging members mounted on said support for movement to engage and compress the pleats formed by said former means to set the creases, and means to move said setting members to engage and compress the pleats after said actuating means has moved said formers to form the pleat and retracted said formers.

21. In a folding machine, a support, guide means mounted on said support for a tubular blank, means mounted on said support to move the tubular blank longitudinally on said guide means, forming means movably mounted on said support to engage the blank to form pleats in the moving tubular blank, and additional means having pleat engaging members mounted on said support to move with the tubular blank engaging opposed sides of the pleats after formation by said forming means and compressing the pleats to set the pleats in the tubular blank.

22. In a bellows folding machine, a support, guide means mounted on said support for a tubular blank, means mounted on said support to move the tubular blank longitudinally of said guide means, forming means movably mounted on said support to form pleats in the tubular blank, an endless member mounted on said support for movement and having a portion moving longitudinally with the moving tubular blank, and means mounted on said portion of the endless member moving with the tubular blank and having parts in spaced relation moving between the pleats after formation by said forming means and adjacent parts moving toward each other to reduce the space to approximately the double thickness of the tubular blank to engage opposite sides of the pleats to compress the pleats to set the crease of the pleats in the tubular blank.

23. In a forming machine, a support, a carrier mounted on said support for longitudinal reciprocating movement, drive means connected to said carrier to reciprocate said carrier, a former transversely slidably mounted on said carrier for movement between a first and a second position, means operably connected to said former to move said former from said first to said second position at one point of said reciprocating movement and means operably connected to said former to move said former from said second to said first position at another point of said reciprocating movement.

24. In a forming machine, a support, a carrier mounted on said support for longitudinal reciprocating movement, drive means connected to said carrier to reciprocate said carrier, a former transversely slidably mounted on said carrier for movement between a first and a second position, a cam mounted on said support and operably connected to said former to move said former from said first to said second position at one point of said reciprocating movement and a second cam mounted on said support and operatively connected to said former to move said former from said second to said first position at another point of said reciprocating movement.

25. In a forming machine, a support, a carrier mounted on said support for longitudinal reciprocating movement, drive means connected to said carrier to reciprocate said carrier, a former mounted for transverse reciprocating movement on said carrier for movement between a first and a second position, means operably connected to said former to move said former from said first to said second position at one point of said reciprocating movement, means operably connected to said former to move said former from said second to said first position at another point of said reciprocating movement, and means to maintain said former in said second position during longitudinal reciprocating movement on said carrier from said one point to said another point and to maintain said former in said first position during longitudinal reciprocating movement on said carrier from said another point to said one point.

26. In a forming machine, a support, a carrier mounted on said support for longitudinal reciprocating movement between a first point and a second point, two-way screw drive means mounted on said support and operatively connected to said carrier to reciprocate said carrier, a former mounted on said carrier for transverse reciprocating movement between a first position and a second position, a first cam mounted on said support adjacent said first point and operatively engaging said former to move said former from said first position to said second position, and a second cam mounted on said support adjacent said second point and operatively engaging said former to move said former from said second position to said first position.

27. In a forming machine, a support, a carrier mounted on said support for longitudinal reciprocating movement

between a first point and a second point, two-way screw drive means mounted on said support and operatively connected to said carrier to reciprocate said carrier, a former mounted on said carrier for transverse reciprocating movement between a first position and a second position, a first cam mounted on said support adjacent said first point and operatively engaging said former to move said former from said first position to said second position, a second cam mounted on said support adjacent said second point and operatively engaging said former to move said former from said second position to said first position, and means to resiliently maintain said former in said second position during longitudinal reciprocating movement on said carrier from said first point to said second point and to resiliently maintain said former in said first position during longitudinal reciprocating movement on said carrier from said second point to said first point.

28. In a folding machine, a support having a ring-like folding station located on the longitudinal axis of the machine, means mounted on said support to guide a tube coaxially to said ring-like folding station, folding means including a former having a portion engageable with the inside of the tubular blank and being located within said ring-like folding station and pivotally mounted on said support adjacent said axis and spaced from said folding station for substantially planar radial outward movement of said portions from adjacent said axis to said ring-like folding station into engagement with the inside of the tube, and drive means to actuate said folding means including said former to form pleats in said tube.

29. In a bellows folding machine, means having an axis to guide a tubular blank coaxially, internal formers mounted within the tubular blank for outward movement away from said axis to contact the inside of said tubular blank, external formers mounted externally of the tube for radial inward and longitudinal movement with respect to said axis to contact the outside of said tubular blank and cooperating with said internal formers contacting the inside of the tubular blank to form pleats in said tubular blank, a drive to move said internal and external formers in coordinated relation, and crease forming means engaging and compressing the pleats to set the crease in said pleats.

30. In a bellows folding machine, a frame, a guide mechanism to guide a tubular blank along its longitudinal axis, drive means on said frame to continuously move said tubular blank longitudinally of said guide along the longitudinal axis of the tubular blank, internal and external formers movably mounted on said frame and located internally and externally of the tube, and means on said frame to move said formers to form bellows pleats having angularly disposed wall portions in said moving tubular blank, and crease forming means to engage and compress said pleats to set the crease.

31. In a bellows folding machine, a frame, guide means mounted on said frame to guide a tubular blank, formers movably mounted on said frame to form a series of axially spaced transverse pleats having a length substantially less than the circumference of said blank, and alternate pleats being transversely angularly spaced from each other, and means mounted on said frame to move a series of plates consisting of more than two between the axially aligned pleats and move said plates together to set the pleats in said tubular blank.

32. In a bellows folding machine, a frame, a guide mechanism mounted on said frame having a longitudinal axis and guiding a tubular blank along its longitudinal axis with its axis parallel to the longitudinal axis of said guide mechanism, means movably mounted on said frame to continuously move the tubular blank longitudinally along its axis, means movably mounted on said frame to form straight transverse pleats extending over a short portion of the circumference of the tubular blank with adjacent pleats circumferentially angularly spaced during continuous movement of the tubular blank, and means mounted on an endless driver mounted on said frame moving with said tubular blank to engage the pleats to compress and set the crease of the pleats in the moving tubular blank.

33. In a folding machine, a frame having a first and second station, a guide mechanism mounted on said frame and having a longitudinal axis and guiding a tubular blank along its axis from said first station to said second station, means mounted on said frame at a first station to form individual pleats in the tubular blank, means mounted on said frame at a second station to set the pleats in the tubular blank and a driver mounted on said frame engaging the tubular blank to move the tubular blank from said first station to said second station.

References Cited in the file of this patent

UNITED STATES PATENTS

898,167	Avery	Sept. 8, 1908
981,200	Kroedel	Jan. 10, 1911
1,290,800	Teall	Jan. 7, 1919
1,453,846	LaCroix	May 1, 1923
1,832,238	Peck	Nov. 17, 1931
1,908,531	Noble	May 9, 1933
1,956,820	Bergstein	May 1, 1934
1,958,459	Angeletti	May 15, 1934
2,033,717	Kopetz	Mar. 10, 1936
2,123,175	Balsam	July 12, 1938
2,169,205	Hornung	Aug. 8, 1939
2,318,849	Grant	May 11, 1943
2,343,096	Stahl	Feb. 29, 1944
2,404,162	Brown	July 16, 1946
2,405,909	Smith et al.	Aug. 13, 1946
2,430,081	Roberts et al.	Nov. 4, 1947
2,468,254	Deloye	Apr. 26, 1949

FOREIGN PATENTS

336,941	Italy	of 1936
361,559	France	of 1906
444,331	Great Britain	Mar. 19, 1936
509,434	Great Britain	July 17, 1939
597,458	Great Britain	Jan. 27, 1948