Aug. 8, 1939. E. J. HORNUNG 2,169,205

CAMERA-BELLOWS-FORMING MACHINE

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FIG. 1.

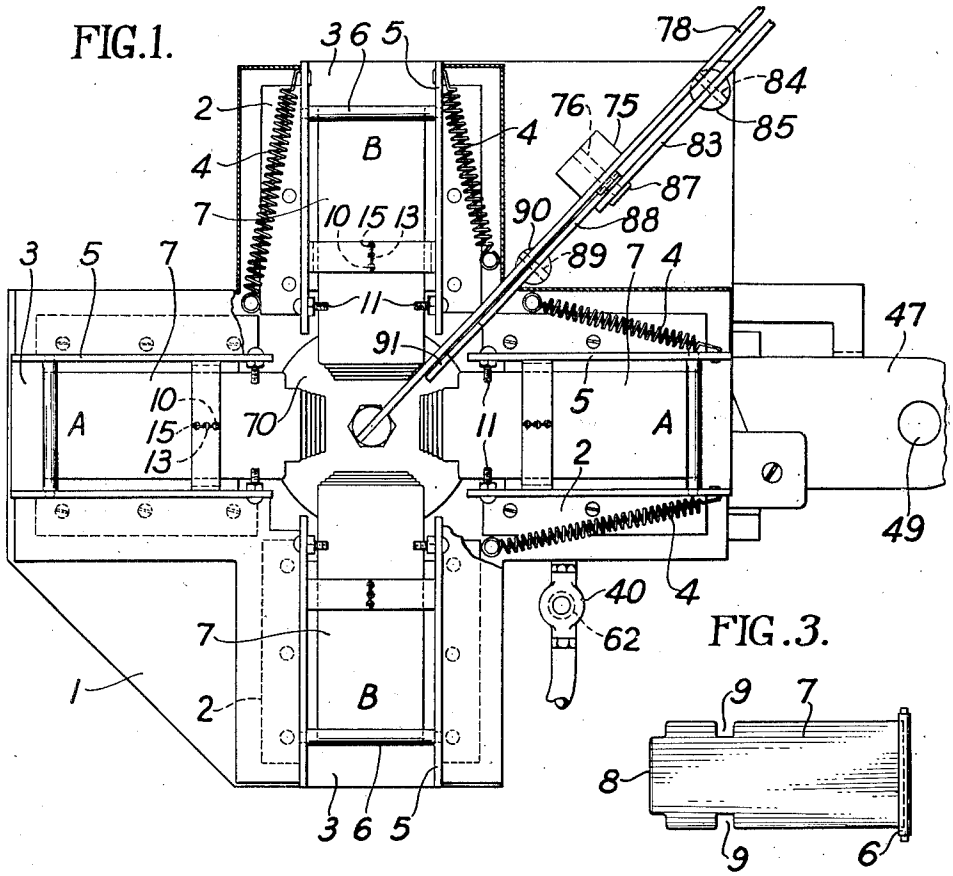
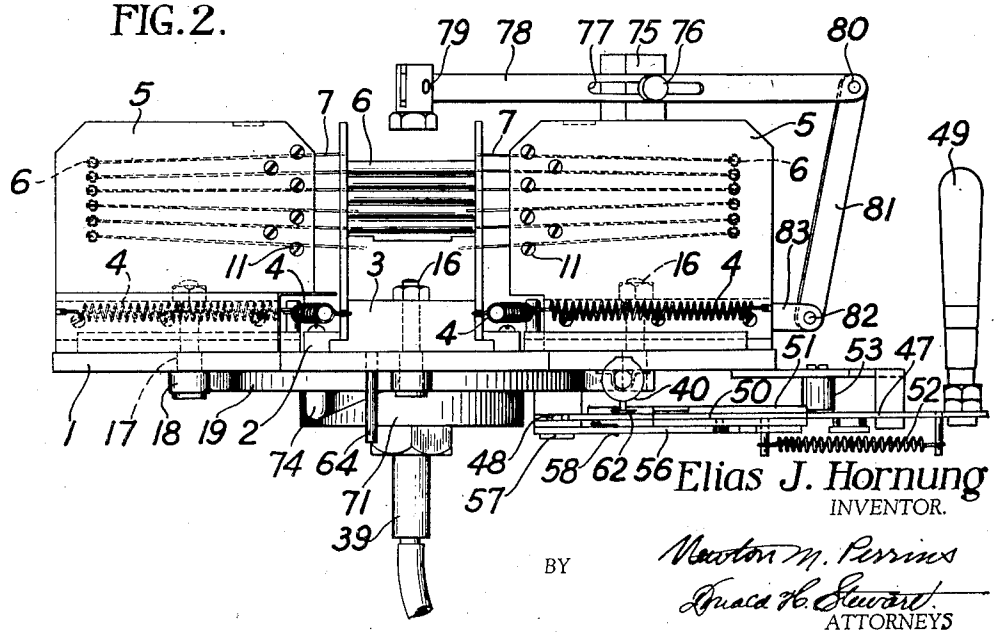


FIG. 3.

FIG. 2.



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FIG. 4.

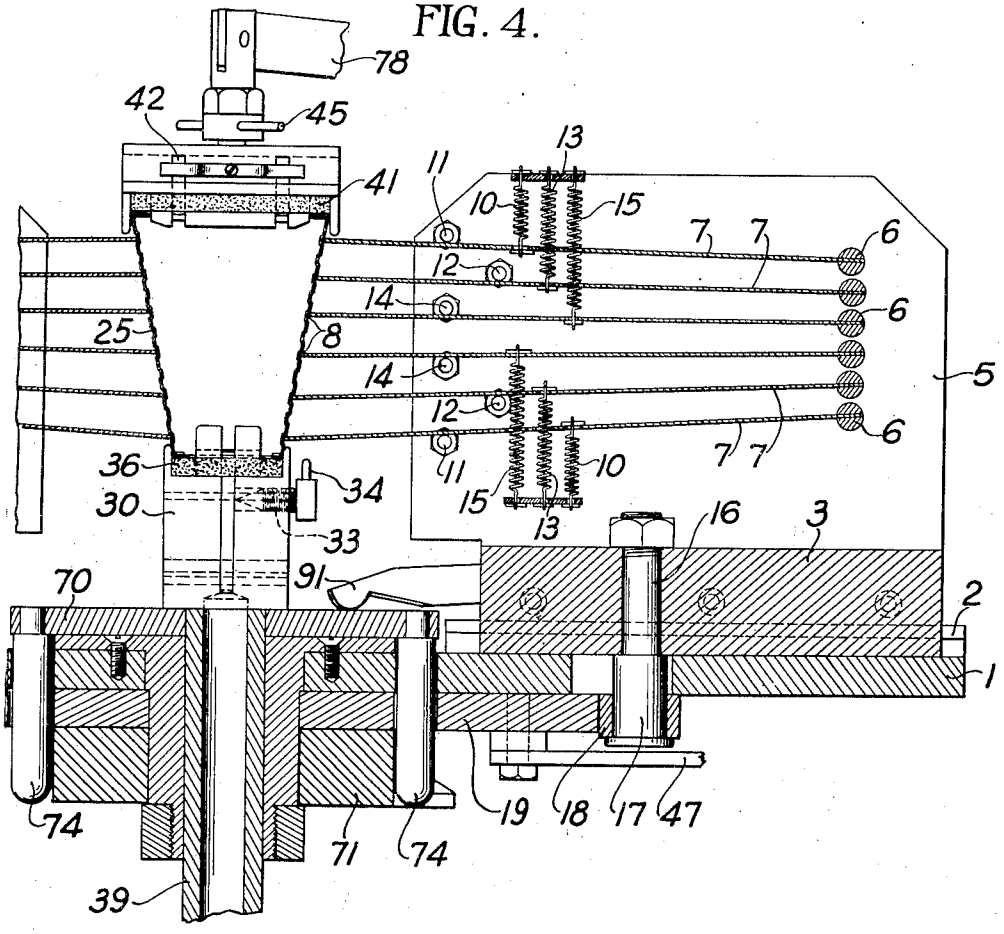
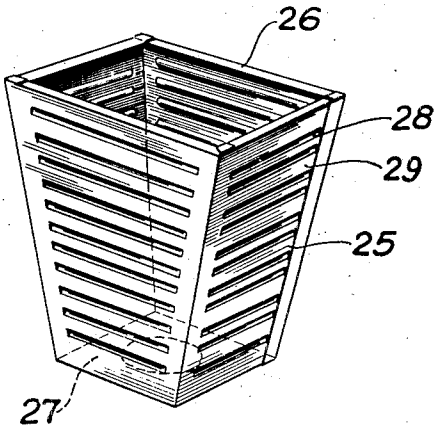


FIG. 5.



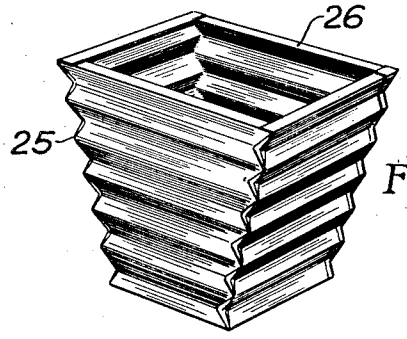


FIG. 6.

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CAMERA-BELLOWS-FORMING MACHINE

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FIG. 7.

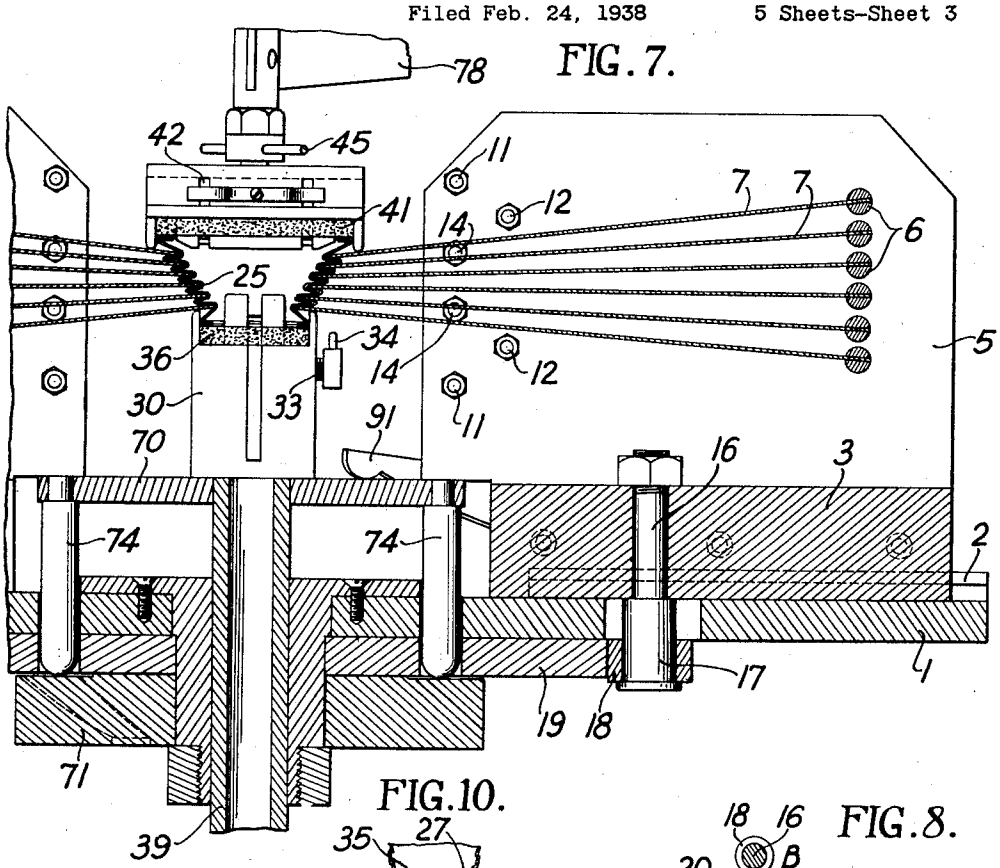


FIG. 10.

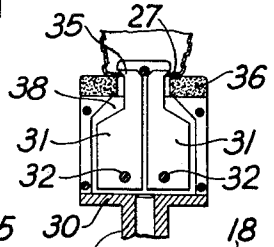


FIG. 11.

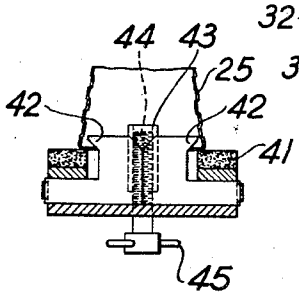


FIG. 8.

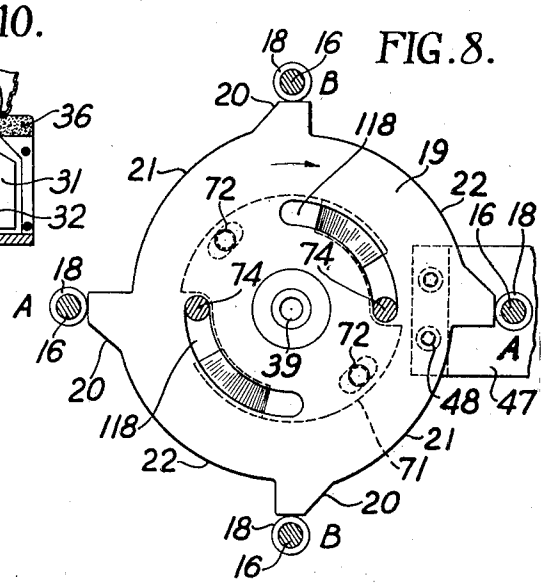
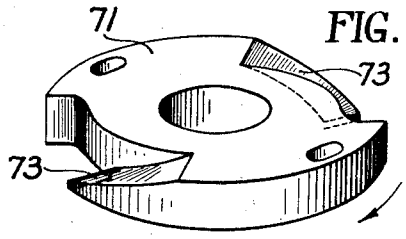


FIG. 9.



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FIG. 12.

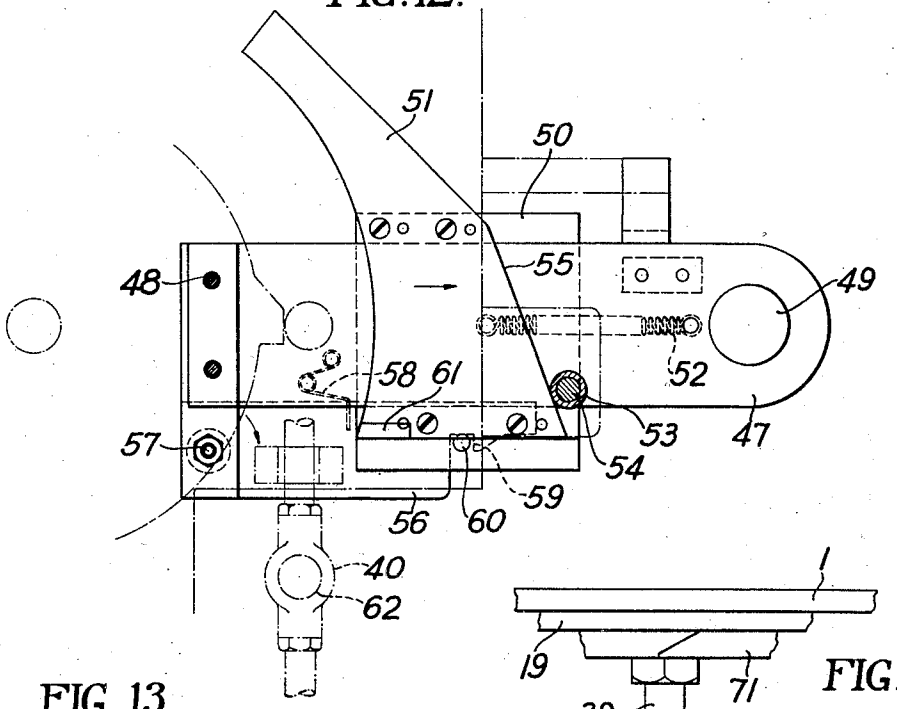
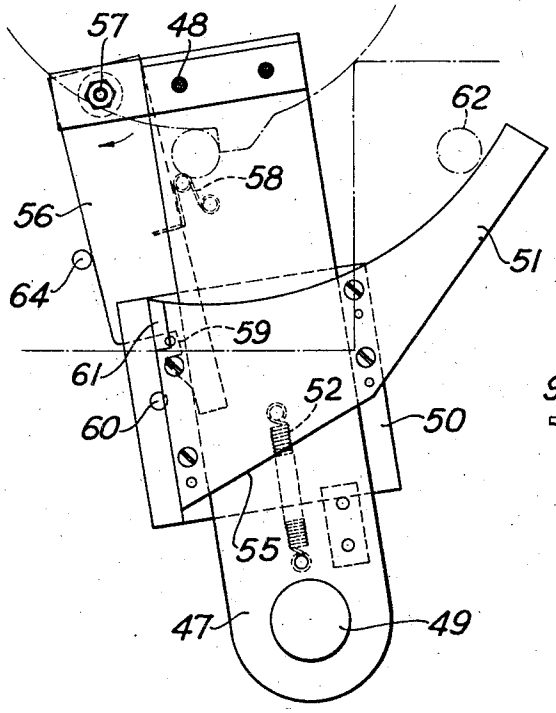


FIG. 13.



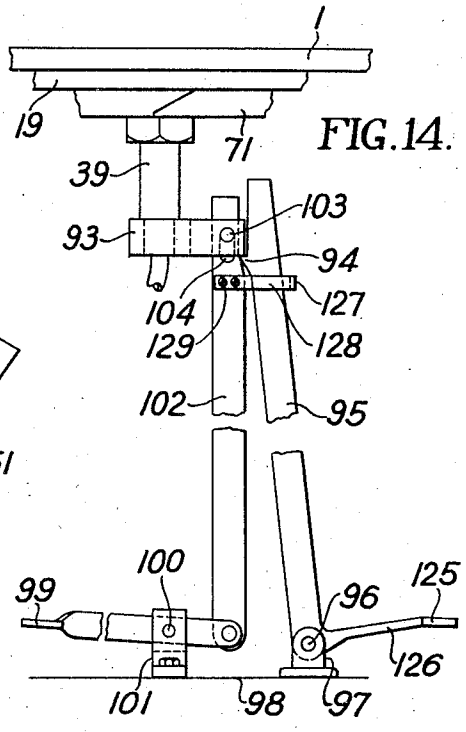


FIG. 14.

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FIG. 15.

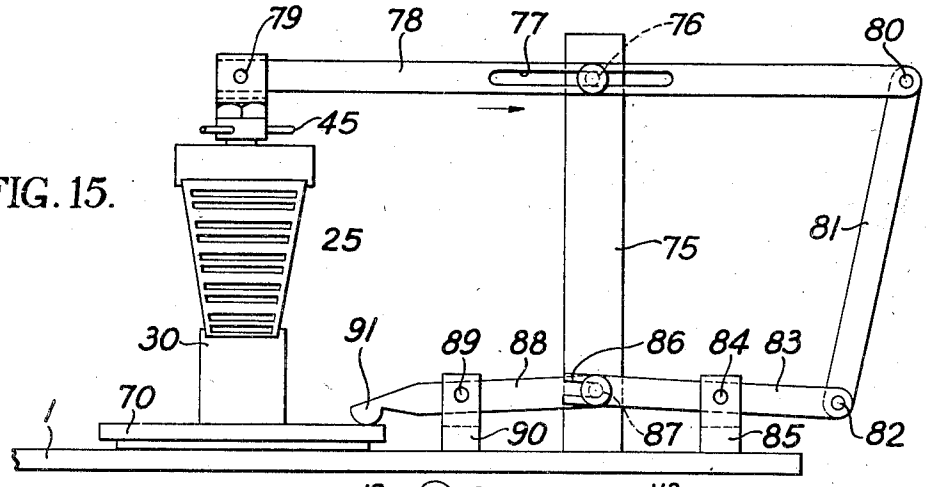


FIG. 16.

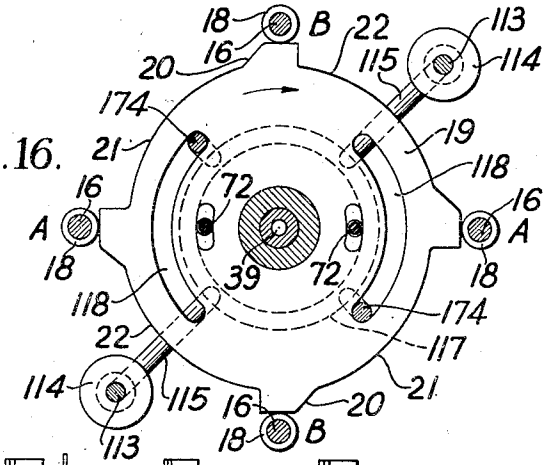
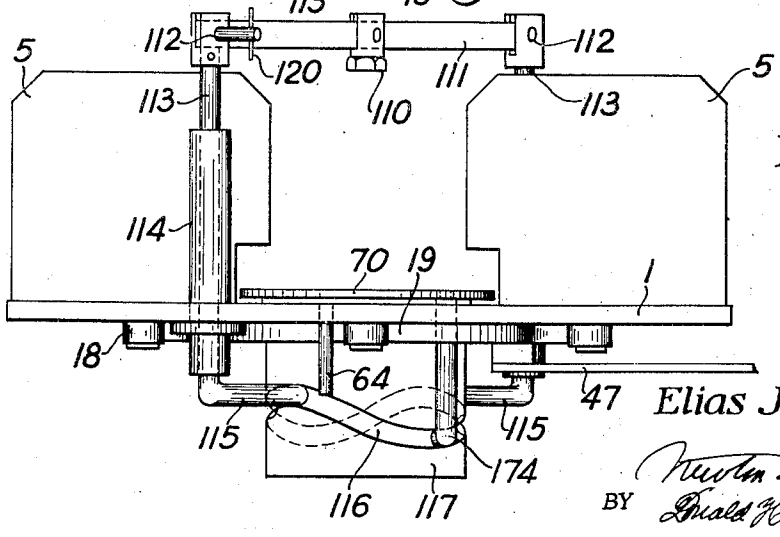


FIG. 17.



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Patented Aug. 8, 1939 2,169,205

UNITED STATES PATENT OFFICE

2,169,205

CAMERA-BELLOWS-FORMING MACHINE

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Application February 24, 1938, Serial No. 192,365

19 Claims. (Cl. 93—36)

This invention relates to machines for forming bellows for folding cameras.

One object of my invention is to provide a machine in which the folds in the bellows can be made automatically so that hand operations will be eliminated. Another object of my invention is to provide a machine into which an unfolded bellows blank can be placed so that by operating the machines, the various folds of the bellows will be accurately formed in proper relationship. Still another object of my invention is to provide a machine which will not only fold the bellows, but will compress the bellows so as to accurately crease the bellows in the proper locations to permit it to fold readily when in a camera. Another object of my invention is to provide a machine into which a bellows blank can be placed which includes a plurality of fold plates which may be simultaneously advanced into contact with the bellows and which may move together as the folds are made and the ends of the bellows approach each other. Still another object of my invention is to provide a machine in which the folds of the bellows are made by bringing fold plates into contact with the fabric of the bellows and using compressed air to force the bellows around the ends of the fold plates into a proper folding position. Other objects will appear from the following specification, the novel features being particularly pointed out in the claims at the end thereof.

One of the relatively expensive parts of a folding camera is the bellows used to connect the camera body with a lens board, since this bellows is largely made by hand. It is customary in making a bellows to provide a lining material, paper or cardboard stiffening members and usually a decorative covering for the bellows. This covering in high grade bellows is usually made from thin leather, but for the less expensive varieties may be of artificial leather. A typical bellows construction is shown in the following patents: U. S. 1,500,391, Hutchings, July 8, 1924 and U. S. 1,908,531, Noble, May 9, 1933. The last-mentioned patent illustrates a satisfactory method of making the bellows blanks which may be folded into a four-sided, open-ended member which, in this application, is called a bellows blank, this blank being adapted for use in the present machine which places the necessary folds in the bellows.

The present machine is designed solely for making the folds and creases in the bellows, the blank for which may have been constructed in any known manner.

Coming now to the drawings wherein like reference characters denote like parts throughout:

Fig. 1 is a top plan view of a bellows folding machine constructed in accordance with and embodying a preferred form of my invention.

Fig. 2 is a side elevation of the bellows folding machine shown in Fig. 1.

Fig. 3 is a fold plate removed from the machine and showing a typical construction.

Fig. 4 is an enlarged fragmentary section showing the relationship of the fold plates and their supports to the bellows blank.

Fig. 5 is a bellows blank as it may appear before the folding operation takes place.

Fig. 6 is a view of the bellows after the blank has been folded to condition the bellows for use in a camera.

Fig. 7 is a view similar to Fig. 4, but with the parts shown in position at the completion of the folding movement.

Fig. 8 is a plan view of a main cam showing its relation to one of the fold plate carriers.

Fig. 9 is a perspective view of a cam which is here shown as being separable from the cam of Fig. 8, but which may be formed integrally therewith.

Fig. 10 is a section through the lower bellows engaging clamp used to support the bellows blank in the machine.

Fig. 11 is a view of the upper bellows clamp.

Fig. 12 is a fragmentary bottom plan view showing a portion of the cam and valve operating mechanism.

Fig. 13 is a similar view, but with the parts in a different position.

Fig. 14 is a fragmentary view of a supplemental bellows creaser which may be used with the machine shown in the preceding figures.

Fig. 15 is a fragmentary view showing the operating mechanism for compressing the bellows.

Fig. 16 is a plan view of an operation cam constructed in accordance with a second embodiment of my invention.

Fig. 17 is a fragmentary side elevation of a modified form of bellows compressor which may be used on my machine.

The broad idea of folding a bellows in accordance with my present invention is that a bellows blank consisting of a square tubular member, usually larger at one end than the other and consisting of four sides which constitutes what I call a bellows blank, can be placed in a machine which will crease the bellows so that it will fold. Fig. 5 illustrates the bellows blank before folding, and Fig. 6 illustrates the blank after fold-

ing. It is customary in such bellows to have light metal rectangular frames supporting both the larger and the smaller end of the bellows, these frames being used to attach the bellows temporarily to the folding machine and later permanently to the camera.

The bellows blank is placed in a machine by clamping the top and bottom frame members with a substantially air-tight clamp to carriers which may be moved toward each other and a plurality of fold plates are mounted on each of the four sides of the bellows so that they may be moved into contact with the bellows and at the same time air is admitted to the inside of the bellows. Thus, the fold plates moving toward each other, combined with the compressed air on the inside of the bellows, cause a series of folds to be made in the bellows, the plates pressing portions of the bellows inwardly while the compressed air presses other portions of the bellows outwardly. As the two ends of the bellows are moved toward each other, the fold plates are compressed also toward each other, permitting these folds to be made.

As indicated in Fig. 1, the machine may consist of a support, such as a tabletop 1 on which there are attached four series of guides 2 in which four supporting members 3 are mounted to move toward and from each other a limited distance. As best illustrated in Fig. 4, each of the supports 3 may move on the guideways 2, and springs 4, as shown in Fig. 1 may be used to normally draw each carriage 3 toward the center of the machine.

Each carriage 3 includes a pair of parallel spaced uprights 5 between which a plurality of shafts 6 extend, each shaft being pivotally mounted in the uprights 5 and carrying a fold plate 7. The fold plates, best shown in Fig. 3, differ somewhat in shape, but each of them consists in a thin plate having an edge 8 adapted to contact with the bellows blank. The difference in these plates is merely a difference in length and a difference in spacing in the notches 9, these notches being arranged to permit the bellows contacting edges 8 of the fold plates to move from the position shown in Fig. 4 to the position shown in Fig. 7. Referring to Fig. 4, it will be noted that the uppermost fold plate 7 is held upwardly by a spring 10 in contact with the end of a stop 11 extending inwardly from the upright plate 5. This is the normal position of rest of this fold plate, but, as will be seen from Fig. 7, as this fold plate moves downwardly, the notches 9 are so arranged that it may pass the stop 12 which is offset to one side of the stop 11. The second fold plate 7 shown in Fig. 4 is normally held upwardly against the stop 12 by means of a spring 13. Thus, this plate must be so notched as to pass the stop member 14 which normally holds fold plate 7 in position as this plate is drawn upwardly by means of a spring 15.

The bottom three fold plates shown in Fig. 4 are the same as the top three but are arranged in reverse order. In other words, each of the fold plates 7 may turn upon its pivot 6 and may move together as the folding operation takes place.

In order to move the four sets of fold plates simultaneously, each of the carriers 3 includes a bolt 16 extending downwardly providing a shaft 17 for a roller 18. This roller is adapted to contact with the cam 19, best shown in Fig. 8, so that the four rollers 18 will move in accordance with the contour of this cam.

This cam is mounted to turn approximately 80° from the position shown in Fig. 8 in a clockwise direction as shown by the arrow. This movement will permit the spring members 4 to move each carriage towards the bellows blank as soon as the rollers 18 roll down the inclines 20 of the cam, this movement bringing each of the fold plates into the position shown in Fig. 4 in contact with the outside walls of the bellows blank. Further movement of the cam moves two sets of the fold plates, while the remaining two sets remain stationary.

Referring to Fig. 1, two of the sets of fold plates are indicated broadly as A and the other two sets of the fold plates are indicated at B. After sets A and B of fold plates are contacted with the bellows, it is only desirable to have sets B of the fold plates continue to move inwardly during the folding movement. For this reason, the cam 19 is provided with surfaces 21 which are inclined toward the center of the cam whereas the surfaces 22 of the cam are substantially concentric with the center, and accordingly, as the cam continues to turn in a clockwise direction, the sets A of the fold plates will remain stationary while the sets B of the fold plates sink further into the bellows.

During the time that the folding operation takes place, the two ends of the bellows blank approach each other. This is accomplished in the following manner: Referring to Fig. 5, the bellows blank 25 is provided with an upper metal frame 26 and a lower metal frame 27. It is understood that this bellows blank may be of the construction shown in either of the two patents referred to above, so that there are actually areas of the bellows, such as 28, which consists of only the outer covering and the inner lining, whereas between these sections, as at 29, there may be reinforcing or stiffening strips. This causes the bellows to fold more readily. But irrespective of the form of the bellows blank, the blank as shown in Fig. 5 is attached to the center of the machine in the following manner: The small end of the bellows—carrying the frame 27—is attached to the lower pad 30 by means of a clamp consisting of a pair of members 31 hinged on pintles 32. These two members are separated by means of a screw 33, best shown in Fig. 4, which, when turned by the handle 34, swings the plates about the pintles 32, causing the hook-like ends 35 to engage the metal frame 27. The face of the clamp may carry a soft rubber pad so that the joint between the lower end of the bellows and the clamping structure is substantially air-tight. By substantially air-tight, I mean sufficiently air-tight to hold air for a short time, although leakage may freely occur around the clamp if the bellows remains held in position for any length of time.

As will also be seen from Fig. 4, the lower clamp includes an air passage 38 which extends upwardly from the pipe 39 and air is admitted to this pipe through a suitable valve 40, as will be hereinafter more fully described.

The upper end of the bellows is also clamped to a soft rubber pad 41 by means of a pair of hook-like members 42 which are separated by means of a wedge 43 carried by a screw 44 which may be operated by the handle 45, as indicated in Fig. 11. This figure shows the parts in a reverse position with respect to Fig. 7.

An operator may, therefore, quickly attach the bellows blank 25 by means of the clamps shown in Figs. 10 and 11 so that the blank will be in the

position shown in Fig. 4 in which it is ready for the folding operation to take place.

Since it is necessary to admit air to the bellows during the time the folding takes place, I prefer to do this as the cam 19 is moved in the following manner: As indicated in Fig. 8, the cam 19 is attached to an arm 47 as by means of bolts 48. This arm extends outwardly as indicated in Fig. 1 and may terminate in a handle 49 which may be used to manually operate the machine by swinging the hand'e in a clockwise direction from the position shown in Fig. 12 to the position shown in Fig. 13. This movement may move the cam approximately 80° so that the fold plates will move as above described and so that air will be admitted to the bellows through valve 40 in the following manner. The arm 47 carries a slide 50, the upper portion of the slide consisting of an arm 51 which is rigidly held to the slide and which is normally moved in the direction shown by the arrow in Fig. 12 by means of a spring 52. However, a roller 53 supported by a shaft 54 carried by the table 1 lies in the position shown in Fig. 12 so that it may contact with the cam wall 55 of the arm 51 and move this member against the pressure of spring 52 as the handle 49 is moved from the position shown in Fig. 13 to that shown in Fig. 12, which is its normal position of rest. The roller 53 and cam 55 move the slide against the direction shown by the arrow in Fig. 12 so that a latch member 56 pivoted at 57 to the arm and spring-pressed by the spring 58 in the direction shown by the arrow may cause the hook 59 to engage the pin 60 carried by the slide. Thus, when the arm 49 is turned, the cam arm 51 will remain in the set position and the beveled surface 61 may engage the curved head 62 of the spring valve plunger permitting air to pass through the valve 40.

As soon, therefore, as handle 49 has been moved approximately a fifth of the distance to fold a bellows, which is the distance necessary to move the fold plates to the position shown in Fig. 4, air is admitted to the bellows so that continued folding operation takes place while air is being admitted to the inside of the bellows.

The amount of air required is not critical and I have found that a pressure of from 15 to 20 pounds on the compressed air line gives entirely satisfactory results. During the folding operation, if the pressure becomes too great, the soft rubber pads 41 and 36 may permit air to escape around the edges of the ends of the bellows.

As soon as the handle 49 has been moved to the position shown in Fig. 13, the latch member 56 will strike an upstanding pin 64 moving the latch away from the holding pin 60 on the slide and permitting the spring 52 to immediately move the air valve cam 51 to the position shown in Fig. 13 in which the valve 62 will be freed from engagement with the cam and will be closed by its spring. Thus, air is cut off just as soon as the handle 49 reaches the position shown in Fig. 13.

Upon returning the handle 49 to its initial position of rest, the cam 55 and roller 53 again move the slide toward the center of the machine into its latched position in which the cam will again engage the pop valve, when the arm moves clockwise.

During the time that the folding operation takes place, when the fold plates engage the bellows and while air is being admitted thereto, the two ends of the bellows are moved toward each other by the mechanism which will now be described. Referring to Fig. 7, there is a plate 70 which carries the lower bellows clamp 38, this plate being slidable on the pipe 39 which passes downwardly through the center of the cams 19 and 71. These cams may be either a single piece of material or may be made of two pieces, as shown, in which case the cam 71 may be attached as by bolts 72 to the cam 19. The cam 71 is provided with inclines 73 which are oppositely disposed as shown in Fig. 9 and the ends of shafts 74 extending downwardly from the plate 70, engage these cam surfaces. Thus, when the handle 49 is turned, the cam 71 is turned and the inclines 73 cause the posts 74 to raise the plate 70 and with it the lower end of the bellows.

At the same time, the upper end of the bellows is brought downwardly by means of the linkage, best shown in Fig. 15. The tabletop 1 supports a post 75 on which there is a stud 76 passing through a slot 77 in an arm 78 pivotally carrying at 79 the upper bellows clamp 42. The opposite end of arm 78 is pivotally attached at 80 to a link 81 pivoted at 82 to a lever 83 which, in turn, is pivoted at 84 to a bracket 85. Lever 83 carries a slot 86 engaging a stud 87 on the lever 88 pivoted at 89 to a bracket 90 and having a curved face 91 engaging the top of the plate 70. Thus, when the plate 70 moves upwardly as described above, this linkage causes the clamp 42 to move downwardly a substantially like amount.

This movement is accomplished by the handle 49, but after the handle 49 has been moved back to its initial position of rest to retract the fold plates and to permit air to escape, it is desirable to crease the bellows still further by further compression of the two bellows clamps, thus creasing the folds just made by the fold plates.

When the maximum compression between the two bellows clamps has been reached through the movement of handle 49, the pipe 39, which also serves as a central shaft, is latched in a downward position as shown in Fig. 14 by the collar 93 which is held in its raised position by means of the latch 94 carried by the latch bar 95 pivoted at 96 to a bracket 97 which may be supported on the floor 98. In order to crease the bellows, the foot treadle 99 may be now depressed, this treadle turning upon the pivot 100 of the bracket 101 so as to thrust upwardly on the connecting rod 102, causing the pin 103 which engages in the slot 104 to raise the pipe 39 still further, thus raising the plate 70 an additional distance. This brings the bellows-holding clamps still closer together, and since the fold plates have been withdrawn by returning the handle 49 to its initial position, the bellows may be creased still further by this final compression by means of the foot treadle 99.

In a modified form of my invention shown in Figs. 16 and 17, the upper bellows clamp carrying member 110 may be carried by a rod 111 supported by the pivots 112 which, in turn, are carried by the slide rods 113. These rods may pass downwardly through suitable bearings 114 and may be formed inwardly at 115 to engage the cam slots 116 cut in the cam sleeve 117 which may, as indicated in Fig. 16, be permanently attached to the cam member 19. This cam member is exactly like the cam member shown in Fig. 8, except that the slots 118 permit the rods 113 to pass through the cam whereas in the cam of Fig. 8, posts 74 move through slots 118. In the form shown in Figs. 16 and 17, the cam slot 116 also carries the ends of posts 174 which carry the plate 70. The shape of the cam slot 116 is such that when the rods 113 are raised, the posts 174

are lowered, and vice versa. This brings the two ends of the bellows together by a mechanism which differs somewhat from that described above.

Referring to Fig. 15, it will be noticed that the lever 78 is provided with a slot 77 which slides about the stud 76. The reason for this is that in operating the machine, the lower end of the bellows—the frame 27—is first attached to the lower bellows clamp, and to facilitate loading and unloading the bellows blank, the upper clamp must be cleared.

With the construction shown in Fig. 15, when the handle 45 has been turned to release the clamps 42, the lever 78 may be slid in the direction shown by the arrow in Fig. 15 to move the clamp away from the top of a bellows which has just been folded so that by releasing the second clamping member by turning the handle 34, best shown in Fig. 4, the folded bellows may be removed.

With the form of the invention shown in Figs. 16 and 17, a supplementary handle 120 is attached to a latch member which releases the top bar 111 permitting it to swing upwardly about its hinge pintle 112.

The operation of my machine is as follows: The operator takes a bellows blank 25, inserts it in the machine, and by a quick turn of handle 34, clamps the bellows frame 27 more or less tightly against the rubber pad 36. Drawing the lever 78 so that the upper rubber pad 41 engages the top frame 26 of the bellows, the operator then turns handle 45, causing the clamping members 42 to hold the bellows in the position shown in Fig. 4. In this position, the fold plates 7 have not yet been brought in contact with the bellows as is shown in Fig. 4.

The handle 49 is now drawn in a clockwise direction. This causes three things to take place. First, the folding plates all move rapidly toward each other and into contact with the walls of the bellows blank. This positioning is shown in Fig. 4. Further movement of the handle simultaneously admits air to the inside of the bellows by operating the spring valve 62 and at the same time, the upper and lower bellows clamps move toward each other. Thus, the bellows is compressed and as the bellows is compressed the fold plates 7 turn about their respective hinges 6 against the action of their springs 10, 13 and 15, so that the compressed air forces the bellows outwardly between the fold plates to fold the blank. As soon as the parts have been brought into the position shown in Fig. 7, in which position the plate 70 is latched in a raised position by means of the latch member 95, the handle 49 reaches a position in which the pin 64 kicks off the latch 56 allowing the slide 50 to move under the impulse of spring 52, thereby releasing the spring valve 62 and cutting off the admission of air through pipe 39. The handle 49 is then returned to the position shown in Fig. 12, but the plate 70 does not descend because of the latch member 94. However, the fold plates are all withdrawn because of the return movement of the handle 49, so that the rollers 18 ride up on the tops of the cam members 20 of cam plate 19. The operator then steps sharply on the foot treadle 99 which creases the bellows by bringing the upper and lower bellows clamping members substantially into contact and by releasing the pressure on the treadle 99, the plate 70 is able to return to its initial position. The parts are then in position to repeat this operation.

It might be pointed out that the latch member 95 may be released for the complete downward movement of plate 70 by means of a foot treadle 125 carried by the arm 126 which may form a part of the latch 95 and which may be located in any convenient position. A strap 127 may be used to limit the outward movement of the latch 95 away from member 93, this strap being preferably attached to the foot treadle rod 102 by means of side arms 128 attached thereto as by means of screws 129.

While it takes considerable time to describe the operation of this machine, the operation is, in fact, a quite rapid one and with a little practice, the operator may very quickly clamp the two ends of the bellows to their respective clamps, swing the arm 45 rapidly through its arc of movement, and return it to its initial position while stepping first on the foot treadle 99 and then the release 125. It is obvious that a machine as above described makes all of the necessary folds in the bellows simultaneously whereas in previous methods of bellows making, each fold was separately made, in most instances, being entirely a hand operation.

What I claim as my invention and desire to be secured by Letters Patent of the United States is:

1. In a bellows folding machine, the combination with substantially air tight clamps for holding the two ends of a bellows blank, of a plurality of movably mounted fold plates, and mechanism for moving said plates toward the bellows blank and for admitting compressed air into said bellows for holding the bellows thereagainst to form folds in the bellows, movably mounted carriers for the clamps, and means for retracting the fold plates and for moving the clamps toward each other for compressing the bellows.

2. In a bellows forming machine, the combination with substantially air tight clamps, one for each end of a bellows blank having four sides, four sets of fold plates, a support on which each set of fold plates is mounted, a movable cam, connections between each support and the cam for simultaneously moving the former by the latter toward and away from the bellows blank, means for admitting compressed air into the bellows to fold the bellows about the fold plates as they are moved towards the bellows blank to form folds therein and for moving the clamps toward each other for compressing the bellows after said cam has moved the fold plates away from the blank.

3. In a bellows forming machine, the combination with substantially air tight clamps, one for each end of a bellows blank having four sides, four sets of fold plates, a support on which each set of fold plates is mounted, a movable cam, connections between each support and the cam for simultaneously moving the former by the latter toward and away from the bellows blank, means for admitting compressed air into the bellows to fold the bellows about the fold plates as they are moved towards the bellows blank to form folds therein, and means for moving the bellows clamps also actuated by said cam to compress the folded bellows and means separate from said cam for compressing the bellows still further to crease the bellows after the fold plates have been moved from the bellows blank.

4. In a bellows forming machine, the combination with substantially air tight clamps, one for each end of a bellows blank having four sides, four sets of fold plates, a support on which each set of fold plates is mounted, a movable cam, connections between each support and the cam

for simultaneously moving the former by the latter toward and away from the bellows blank, means for admitting compressed air into the bellows to fold the bellows about the fold plates as they are moved towards the bellows blank to form folds therein, and means for moving the bellows clamps also actuated by said cam to compress the folded bellows, a supplementary means for moving the bellows clamps toward each other separate from the cam for imparting a final creasing to said bellows, said supplementary means including bodily moving the cam and bellows clamps toward each other after the removal of the fold plates.

5. In a bellows forming machine, the combination with substantially air tight clamps, one for each end of a bellows blank having four sides, four sets of fold plates, a support on which each set of fold plates is mounted, a movable cam, connections between each support and the cam for simultaneously moving the former by the latter toward the bellows blank, and means for admitting compressed air into the bellows to fold the bellows about the fold plates as they are moved towards the bellows blank to form folds therein, said compressed air admitting means including a valve, an arm for operating the valve, the arm being shaped to open and close the air valve through movement in one direction.

6. In a bellows forming machine, the combination with substantially air tight clamps, one for each end of a bellows blank having four sides, four sets of fold plates, a support on which each set of fold plates is mounted, a movable cam, connections between each support and the cam for simultaneously moving the former by the latter toward the bellows blank, and means for admitting compressed air into the bellows to fold the bellows about the fold plates as they are moved towards the bellows blank to form folds therein, said compressed air admitting means including a valve, an arm for operating the valve, the arm being shaped to open and close the air valve through movement in one direction, and connections between said arm and said cam for operating the latter from the former.

7. In a bellows forming machine, the combination with substantially air tight clamps, one for each end of a bellows blank having four sides, four sets of fold plates, a support on which each set of fold plates is mounted, a movable cam, connections between each support and the cam for simultaneously moving the former by the latter toward the bellows blank, and means for admitting compressed air into the bellows to fold the bellows about the fold plates as they are moved towards the bellows blank to form folds therein, said compressed air admitting means including a valve, an arm for operating the valve, the arm being shaped to open and close the air valve through movement in one direction, and a hinged latch cooperating with the valve and arm whereby movement of the arm in an opposite direction may not operate said valve.

8. In a bellows forming machine, the combination with substantially air tight clamps, one for each end of a bellows blank having four sides, four sets of fold plates, a support on which each set of fold plates is mounted, a movable cam, connections between each support and the cam for simultaneously moving the former by the latter toward the bellows blank, and means for admitting compressed air into the bellows to fold the bellows about the fold plates as they are moved towards the bellows blank to form folds therein, said compressed air admitting means including a valve, a movably mounted arm, an operating lever carrying the movably mounted arm, a latch for holding the arm in position to operate the valve in moving in one direction, means for releasing the arm for moving from a valve operating position when moved in a reverse direction by the operating lever.

9. In a bellows forming machine, the combination with four sets of fold plates, each set comprising a support including a pair of uprights, a plurality of shafts each shaft carrying a fold plate, a plurality of stops and a spring for holding each fold plate against a stop.

10. In a bellows forming machine, the combination with four sets of fold plates, each set comprising a support including a pair of uprights, a plurality of shafts, each shaft carrying a fold plate, a plurality of stops, a spring for holding each fold plate against a stop, each set of stops being spaced differently from the shafts for the fold plates, and each fold plate including notches to clear the stops of at least the next adjacent fold plate, whereby all the fold plates may be moved toward each other.

11. In a bellows folding machine, the combination with two substantially air tight clamps and gaskets, one for clamping each end of a bellows blank against a gasket, four sets of fold plates, means for moving each set of fold plates into contact with the bellows blank, and means for admitting air into the bellows in timed relation to the movement of the fold plates, said means for moving the fold plates including means for also moving two of the four sets of fold plates still further into the bellows while air is being admitted into the bellows to fold the bellows about the fold plates.

12. In a bellows folding machine, the combination with two substantially air tight clamps and gaskets, one for clamping each end of a bellows blank against a gasket, four sets of fold plates, means for moving each set of fold plates into contact with the bellows blank, and means for admitting air into the bellows in timed relation to the movement of the fold plates, said means for moving the fold plates including means for also moving two of the four sets of fold plates arranged on opposite sides of the bellows still further into the bellows while holding the remaining two sets of fold plates in a fixed position relative to each other.

13. In a folding machine for bellows blanks shaped like a truncated pyramid, the combination with a pair of bellows clamps, one for holding each end of a bellows, of a plurality of fold plates arranged in pairs, a support on which said fold plates may move, a cam for moving the sets of fold plates into engagement with the walls of the truncated pyramid bellows blank, said cam being shaped to continue movement of certain fold plates to fold sections of the truncated pyramid blank inwardly, said cam including means for moving the bellows and clamps and fold plates toward each other thus compressing and folding the walls of the truncated pyramid blank forming certain walls of the blank differently from other walls thereof, said cam also being shaped to withdraw the fold plates from contact with the folded bellows, and means for compressing the bellows folds against each other after the removal of the fold plates.

14. In a folding machine for bellows blanks shaped like a truncated pyramid, the combination with a pair of bellows clamps, one for holding

each end of a bellows, of a plurality of fold plates arranged in pairs, a support on which said fold plates may move, a cam for moving the sets of fold plates into engagement with the walls of the truncated pyramid bellows blank, said cam being shaped to continue movement of certain fold plates to fold sections of the truncated pyramid blank inwardly, said cam including means for moving the bellows and clamps and fold plates toward each other, thus compressing and folding the walls of the truncated pyramid blank differently from other walls thereof, said cam also being shaped to withdraw the fold plates from contact with the folded bellows, a valve operating mechanism operable in timed relation to the movement of the bellows fold plates for admitting air to the bellows as the fold plates move forwardly and releasing the air from the bellows when the fold plates move from the bellows, and means for compressing the bellows after the removal of the fold plates.

15. In a bellows forming machine, the combination with substantially air tight clamps, one for each end of a truncated pyramid shaped bellows blank having four sides, four sets of fold plates, a support on which each set of fold plates is mounted, a movable cam, connections between each support and the cam for simultaneously moving the former by the latter toward the bellows blank, the cam being so shaped that both sets of fold plates are moved into engagement with the bellows blank and so that continued movement thereof moves only two of the four fold plates to fold the blank inwardly, whereby different folds in the bellows blank may be formed, and means for admitting compressed air into the bellows to fold the bellows about the fold plates as they are moved towards the bellows blank to form folds therein, said compressed air admitting means including a valve, an arm for operating the valve, the arm being shaped to open and close the air valve through movement in one direction.

16. In a bellows forming machine, the combination with substantially air tight clamps, one for each end of a truncated pyramid shaped bellows blank having four sides, four sets of fold plates, a support on which each set of fold plates is mounted, a movable cam, connections between each support and the cam for simultaneously moving the former by the latter toward the bellows blank, the cam being so shaped that both sets of fold plates are moved into engagement with the bellows blank and so that continued movement thereof moves only two of the four fold plates to fold the blank inwardly, whereby different folds in the bellows blank may be formed, and means for admitting compressed air into the bellows to fold the bellows about the fold plates as they are moved towards the bellows blank to form folds therein, said compressed air admitting means including a valve, an arm for operating the valve, the arm being shaped to open and close the air valve through movement in one direction, and supplementary means for finally compressing the formed bellows blank after release of the air and retraction of the fold plates.

17. In a bellows folding machine, means for supporting a bellows blank having the shape of a truncated pyramid, a plurality of sets of fold plates, means for moving the fold plates into contact with the bellows blank for defining the location of certain folds, and means for creating air pressure inside of the bellows to move portions of the bellows between the fold plates, said means for moving the fold plates with the bellows blank also moving the fold plates on two adjacent sides of the bellows blank differentially whereby one set of fold plates may continue to move while the other set remains stationary to differently fold adjacent sides of the bellows and form corner folds therein.

18. In a bellows folding machine for a bellows blank including four walls and shaped like a truncated pyramid, means for supporting the two ends of the bellows blank, four sets of fold plates, means for moving the fold plates to and from the bellows, said means including means for contacting the four sets with the four walls thereof and retracting said sets from the bellows blank, two of each set being similarly spaced from the ends with two of each set spaced differently from the other two sets, whereby the lines of contact between the fold plates engaging two sides of the blank are spaced from the lines of contact between the fold plates engaging the other two sides thereof, said means also including means for moving two sets of fold plates toward each other while holding the other two sets in contact position to differentially fold the sides of the bellows blank and the corners thereof and said means also including means for admitting and releasing compressed air into the bellows for pressing the bellows blank between the sets of fold plates.

19. In a bellows folding machine for a bellows blank including four walls and shaped like a truncated cone, means for supporting the two ends of the bellows blank, four sets of fold plates, means for moving the fold plates to and from the bellows, said means including means for contacting the four sets with the four walls thereof and retracting said sets from the bellows blank, two of each set being similarly spaced from the ends with two of each set spaced differently from the other two sets, whereby the lines of contact between the fold plates engaging two sides of the blank are spaced from the lines of contact between the fold plates engaging the other two sides thereof, said means also including means for moving two sets of fold plates toward each other while holding the other two sets in contact position to differentially fold the sides of the bellows blank and the corners thereof and said means also including means for admitting and releasing compressed air into the bellows for pressing the bellows blank between the sets of fold plates, and mechanical means for compressing and creasing the bellows after the fold plates are retracted and air is released from the bellows.

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