Feb. 25, 1969 L. O. ALFORD, JR 3,429,568

METHOD AND APPARATUS FOR FOLDING SHEETS

Filed April 11, 1966 Sheet 1 of 4

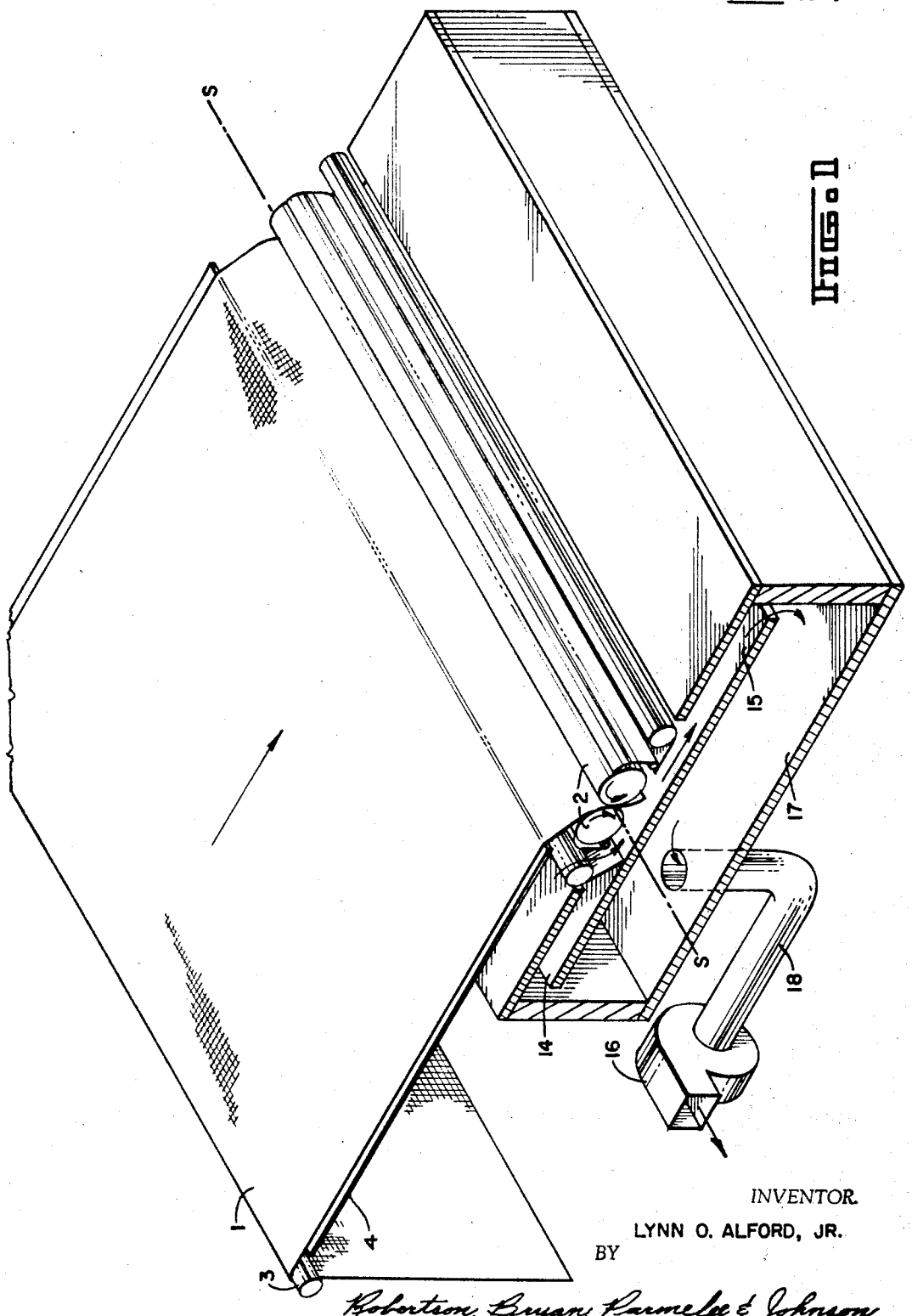


FIG. 1

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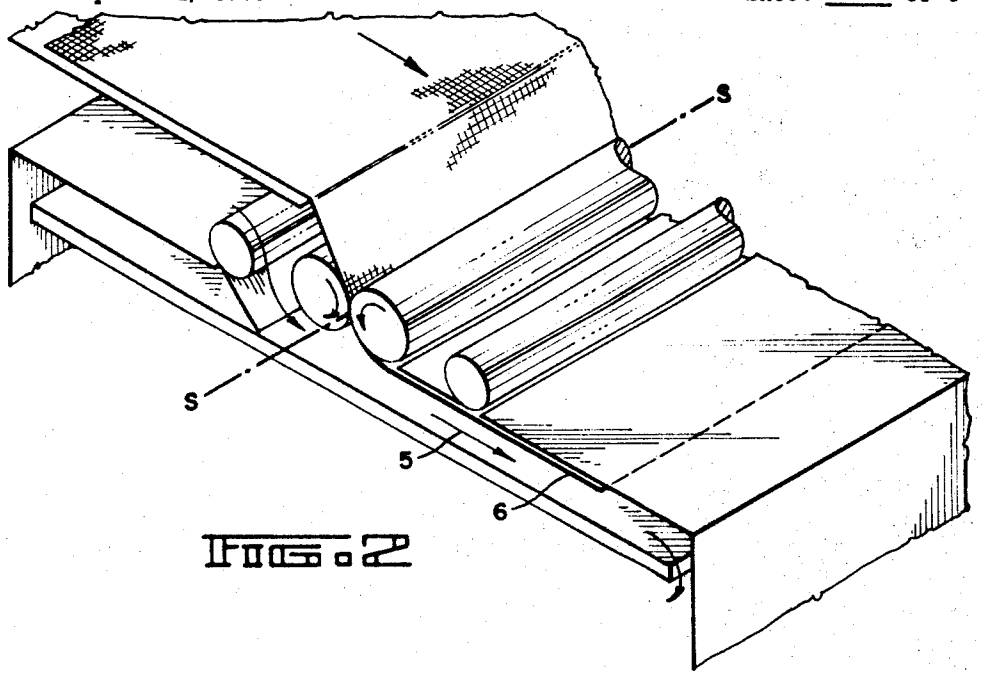


FIG. 2

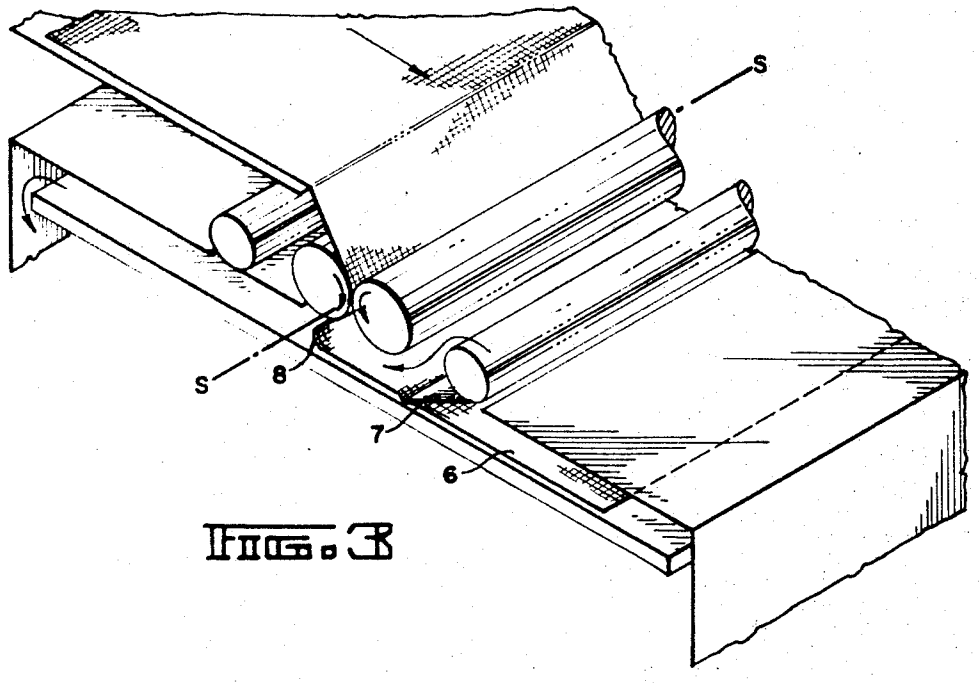


FIG. 3

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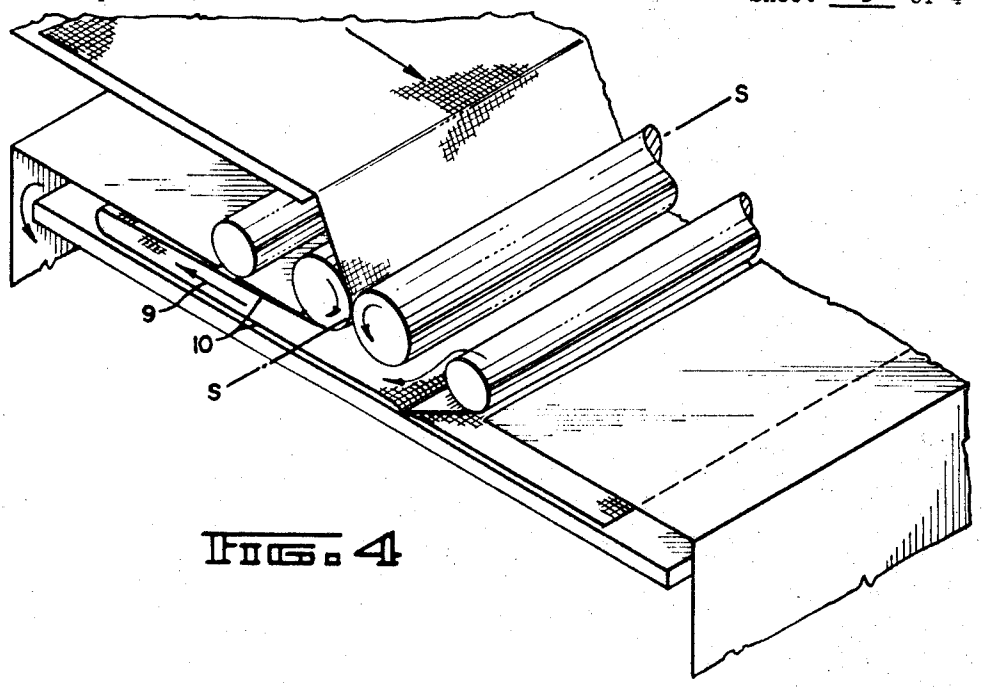


FIG. 4

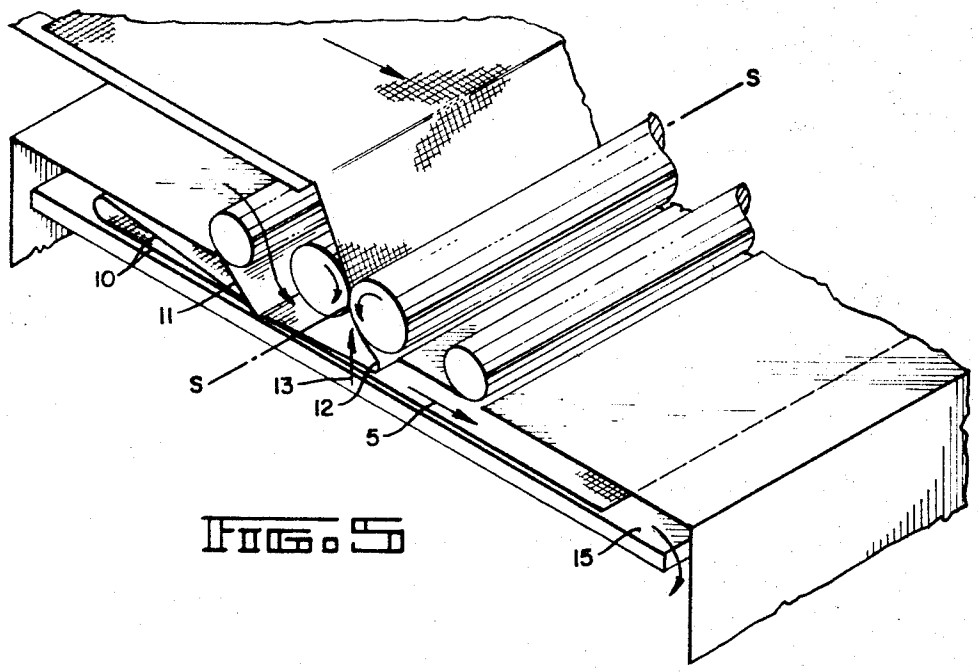


FIG. 5

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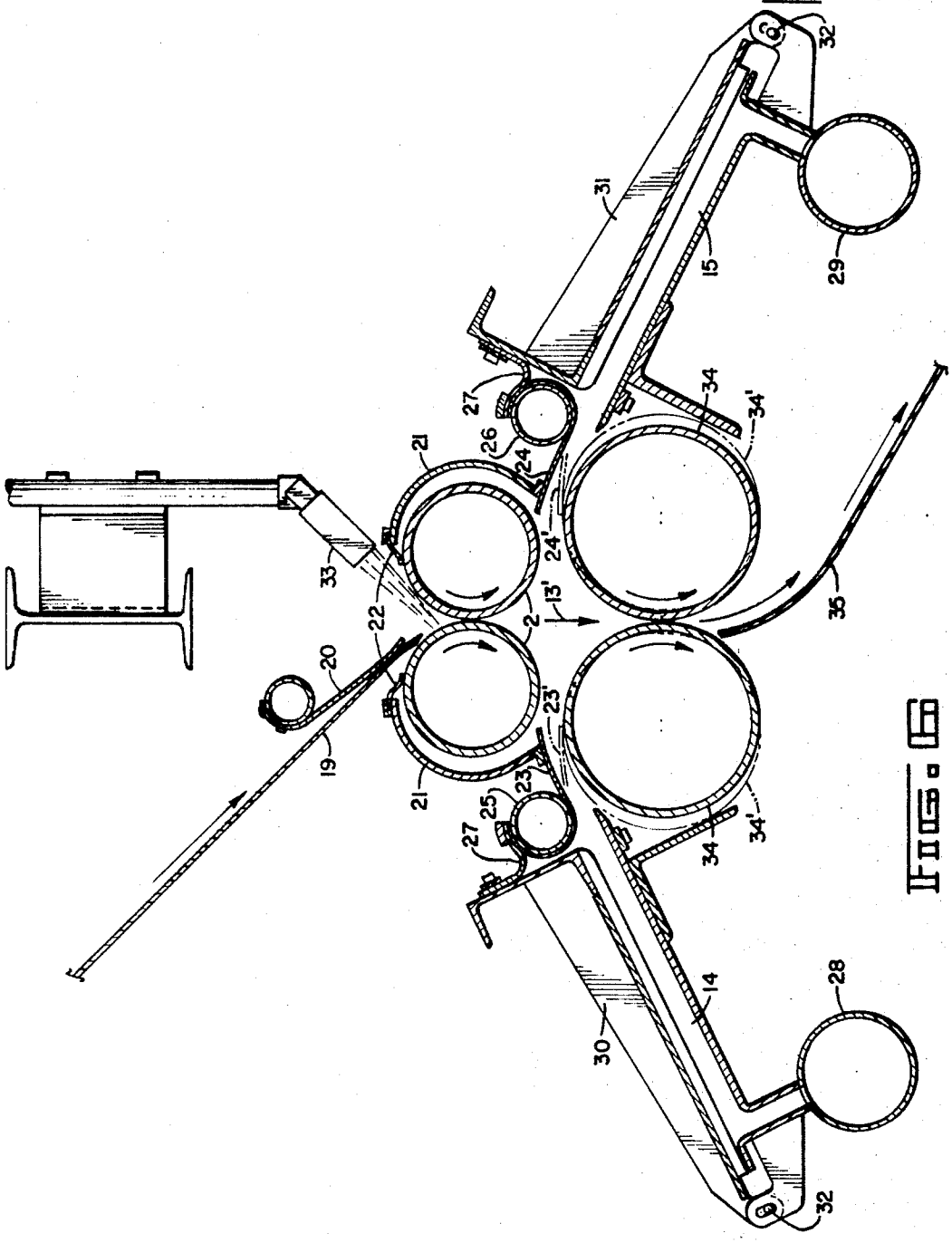


FIG. 6

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METHOD AND APPARATUS FOR FOLDING SHEETS

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Filed Apr. 11, 1966, Ser. No. 547,063
U.S. Cl. 270—69 7 Claims
Int. Cl. B65h 45/20

ABSTRACT OF THE DISCLOSURE

A sheet is fed to a switching station intermediate two suction boxes. Air flow in alternate directions causes the sheet to be drawn into alternate suction boxes in an accordian pleated state. The accordian pleated sheet may be withdrawn between a lower pair of rolls to make a final fold.

This invention relates to a method and apparatus for folding sheets. It has special application to folding bed sheets, but is useful also for folding other kinds of sheets such as tablecloths, towelling, plastic sheet materials and almost any sheet material that is fairly flexible so as to be capable of folding.

Summary

The common method of folding bed sheets and the like is to fold first along a centerline of the sheet, making a double sheet of one-half the size of the flat unfolded sheet, then to fold the double sheet along its centerline (parallel to the original fold line), making four thicknesses of material one-quarter the original size, and so on, folding this way and that until reaching the desired final dimensions for packaging. This has proved to be a cumbersome practice whether performed by hand or machine, and if by machine imposes the need for elaborate mechanism to do the job.

According to my invention the sheet to be folded is laid down in a steady back and forth manner which forms an accordian fold in a series of repeated reversals of direction produced by creating a pressure differential on opposite sides of the sheet with reversal of the pressure (or suction) so that the lower pressure occurs first on one side of the sheet to pull it in one direction, then on the other side to pull it in another direction, followed again by a reversal to pull in the first direction and so on until the last of the sheet has been laid into its folded state within the desired predetermined dimension. An essential aspect of the invention resides in the concept of reversal in direction of the pressure differential in combination with the steps of holding the fold or folds toward one side of a switching station as the following portion of the sheet is being pulled into a fold at the other side of such station. Another aspect of the invention resides in the concept of the apparatus by which the method can best be performed.

Description

With reference to the accompanying drawings I shall now describe the best mode contemplated by me for carrying out my invention.

FIGS. 1 to 5 are a series of diagrams to explain the sequence of steps to be performed in carrying out my invention,

FIG. 1 being a diagrammatic perspective view showing the leading edge of the sheet as it reaches the "switching station,"

FIG. 2 a similar view showing the step of advancing the leading edge of the sheet in one direction,

FIG. 3 a similar view showing the step of holding the portion of the sheet so advanced while creating a pressure differential on opposite sides of a following portion of the sheet to pull it in another selected direction,

FIG. 4 showing the completion of the step begun in FIG. 3,

FIG. 5 showing the step of holding the first folded portion while creating a reversed pressure differential to pull the next following portion of the sheet in the first selected direction to form a second folded portion, and

FIG. 6 is a vertical cross sectional view, partly in elevation, of a preferred form of apparatus embodying my invention.

In FIG. 1 we see a sheet **1** feeding in its flat unfolded state to a switching station S—S. From an apparatus aspect, the switching station is in the region of the feed rolls **2, 2** which are suitably driven in the directions shown by the arrows to pull the sheet over a bar or roller **3** and feed table **4**, carrying the leading edge of the sheet downwardly between the feed rolls. In FIG. 2 we see the leading edge of the unfolded sheet advancing in a selected direction **5** for a predetermined distance. In FIG. 3 the portion **6** of the sheet so advanced is held, as by means of valve plate **7**, while a pressure differential is created on opposite sides of a following portion **8** of the sheet to pull it in another selected direction **9**, FIG. 4, from the switching station S—S for a predetermined distance to form a first folded portion **10**. According to the next step of my method, the first folded portion **10** is then held, as by means of valve plate **11**, FIG. 5, while a reversed pressure differential is created on opposite sides of the next following portion **12** of the sheet to pull it in the first selected direction **5** for a predetermined distance to form a second folded portion. The steps illustrated in FIGS. 4 and 5 are repeated alternately until the trailing edge of the sheet has been reached and the sheet has been folded into an accordion pleated state.

As a further step, my method advantageously includes also the operation of drawing the center of the accordion pleated sheet in a third selected direction **13**, FIG. 5 or **13'**, FIG. 6, while constraining the edges of the pleated sheet in a manner to bring them together in a final fold. This step will be considered further in relation to a preferred form of apparatus constructed according to my invention.

The means for creating the pressure differential advantageously may comprise suction boxes **14, 15**, FIGS. 5 and 6, to receive the folds of the sheet in the respective selected directions and valving means **7** and **11** for closing off the entrance first of one suction box and then the other to produce successively the aforesaid pressure differential and reversed pressure differential. The two suction boxes may be connected to a common vacuum blower **16**, FIG. 1, as by means of a manifold **17** and suction line **18**.

Apparatus for performing the method described, first of all comprises means for performing the several steps as described. A preferred form of such apparatus is shown in FIG. 6, to which reference is now made. The means for feeding the sheet **1** comprises a pair of feed rolls **2, 2** which may be geared together and suitably driven either manually or from a conventional source of power as desired. The sheet is drawn into the feed rolls over a guide **19** and under a guide **20**. Rolls **2, 2** also serve to advance the leading edge of the sheet into one or the other of suction boxes **14, 15**. Covers **21, 21** partly surround the feed rolls and have flexible sealing lips **22, 22** to create pressure seals for holding the pressure differential or suction

used to pull the successive folds of the sheet into the two suction boxes. Valving means **23, 24** are pivotally mounted as upon tubes or axles **25, 26** so as to swing from the full line positions shown into the dotted line positions **23', 24'**. Axles **25, 26** are sealed to the suction boxes **14, 15** by means of flexible impervious cloth **27** or the like suitably secured at one side to the axle and at the other to the box. When valve **23** is in its **23'** position (closed) and valve **24** is in its full line position (open), the sheet will be drawin into suction box **15** in the manner previously described with reference to FIGS. 2 and 5. When valve **23** is open and valve **24** closed, the sheet will be drawn into the other suction box, to wit box **14**. Boxes **14** and **15** are in communication with suction headers **28, 29** which may advantageously be connected to a common manifold leading to a suction blower or other source of vacuum or reduced pressure such as described with reference to FIG. 1.

The suction boxes **14, 15** preferably have hinged cover sections **30, 31** loosely pivoted as at **32** so that the boxes can be opened for inspection and cleaning. If desired, suitable controls may be provided for automatic or semi-automatic operation. Thus a photo-electric eye **33** may be mounted as shown to sense the trailing end of the sheet and initiate steps for removal of the folded sheet. In one advantageous manner of removing the folded sheet, I provide a pair of rubber-covered rolls **34** which are mounted for movement into spaced relationship as indicated by their dotted line positions at **34'**. This permits the folded sheet to be drawn downwardly between rolls **34** for passage into a chute **35** for delivery to a packing table or discharge conveyor as desired. In this step the center of the accordion pleated sheet is drawn in the "third selected direction" **13'** and rolls **34** constrain the edges of the pleated sheet in a manner to bring them together in a final fold.

The predetermined distances to which the sheet is drawn into the respective suction boxes **14** and **15** may be made purposely unequal, if desired, so that more of the accordian pleated sheet finally lies in one of the boxes **14** or **15** than in the other. Thus, when the "center" of the accordian pleated sheet is drawn in the "third selected direction" **13** or **13'** the resulting final fold is actually located along a line which is offset from the centerline. For example, the final fold may be located along a line which is positioned one-third of the way across the width of the accordian pleated sheet, and then when the edges are brought together during this final fold they are offset from each other to provide a particular configuration for packaging.

It will be appreciated that the method and apparatus of this invention provide advantages in folding bed sheets, tablecloths, towelling, curtains, drapes, and the like. Regardless of the particular size of the flat, unfolded sheet **1**, the width of the accordian pleated sheet which is produced after folding can be made the same in each case, so as to fit a standard width of package. A larger sheet **1** produces a larger number of accordian folds, but the width of the accordian pleated sheet is established by the predetermined distances that the sheet is drawn in the directions **5** and **9** into the respective suction boxes **14** and **15**. Accordingly, a standard width of accordian pleated sheet can be produced in each case, regardless of the initial size of the flat sheet **1**, without altering the method or adjusting the apparatus.

Conversely, the width of the accordian pleated sheet can be adjusted quickly and easily, to provide folded sheets of different over-all sizes, by changing the respective predetermined distances that the sheet is drawn into the suction boxes **14** and **15**.

The terms and expressions which I have employed are used in a descriptive and not a limiting sense, and I have no intention of excluding equivalents of the invention described and claimed.

I claim:

1. Method of folding sheets which comprises the steps of:

(a) feeding the sheet in the flat unfolded state to a switching station,

(b) creating a flow of air from said switching station in a selected direction into a first suction box,

(c) advancing the leading edge of the unfolded sheet in said selected direction by said flow from said switching station for a predetermined distance into said first suction box,

(d) holding stationary the portion of the sheet so advanced,

(e) creating a pressure differential on opposite sides of a following portion of the sheet and creating a flow of air from said switching station in another selected direction into another suction box to pull it by said air flow in said other selected direction from said switching station for a predetermined distance into said other suction box to form a first folded portion,

(f) holding stationary said first folded portion,

(g) creating a reversed pressure differential on opposite sides of the next following portion of the sheet and creating a flow of air from said switching station in said first selected direction into said first suction box to pull it by said air flow in the first selected direction for a predetermined distance into said first suction box to form a second folded portion,

steps (d), (e), (f) and (g) being repeated until the trailing end of the sheet has been reached and the sheet has been folded into an accordian pleated state.

2. The method according to claim **1** which includes also the step of:

(h) drawing the center of the accordian pleated sheet in a third selected direction while constraining the edges of the pleated sheet in a manner to bring them together in a final fold.

3. Apparatus for folding sheets which comprises:

(a) means defining a switching station,

(b) means for feeding the sheet in its flat unfolded state to said switching station,

(c) means defining first and second suction boxes,

(d) suction means for advancing the leading edge of the unfolded sheet in a selected direction from said switching station into said first suction box for a predetermined distance,

(e) means for holding stationary the portion of the sheet so advanced while creating a pressure differential on opposite sides of a following portion of the sheet to pull it in another selected direction from said switching station into said second suction box for a predetermined distance to form a first folded portion, and

(f) means for holding stationary said first folded portion while creating a reversed pressure differential on opposite sides of the next following portion of the sheet to pull it in the first selected direction into said first suction box for a predetermined distance to form a second folded portion,

means (e) and (f) being capable of repeated successive operation as desired to fold the sheet into an accordian pleated state.

4. Apparatus according to claim **3** which also includes:

(g) means for drawing the center of the accordian pleated sheet in a third selected direction while constraining the edges of the pleated sheet in a manner to bring together in a final fold.

5. Apparatus according to claim **3** in which the means for creating the pressure differential comprises valving means for closing off the entrance first of one suction box and then the other to produce successively said pressure differential and reversed pressure differential.

6. Apparatus for folding sheets which comprises:

(a) means defining a switching station,

(b) means for feeding the sheet in its flat unfolded state to said switching station,

(c) means defining first and second suction boxes extending generally in different directions from said switching station,

(d) means creating a pressure differential between said switching station and the interior of said suction boxes such that there is a lower pressure within said suction boxes as compared with switching station,

(e) said first and second suction boxes having first and second entrances, respectively said entrances each communicating with said switching station,

(f) first and second holding means for holding the sheet after it has been advanced into the respective suction boxes, and

(g) first and second valving means capable of repeated successive operation for closing off said first and second entrances, respectively, in sequence, to produce successively a flow into the first of said suction boxes for advancing the leading edge of the unfolded sheet in a selected direction from said switching station into said first suction box for a predetermined distance to be held in said first suction box by said first holding means, then producing a reversed flow into the second suction box to pull it in another selected direction from said switching station for a predetermined distance into said second suction box to form a first folded portion to be held in said second suction box by said second holding means, and then producing a reversed flow by the next following portion of the sheet to pull it again in the first selected direction from said switching station for a predetermined distance into said first suction box to form a second folded portion to be held in said first suction box by said first holding means, and so forth to fold the sheet into an accordian pleated state.

7. Apparatus for folding sheets as claimed in claim 6 in which said means defining a switching station includes:

(h) a pair of feed rolls between which the flat unfolded sheet is fed downwardly,

(i) a pair of covers near the respective feed rolls,

(j) flexible sealing lips extending between said covers and the respective feed rolls to provide pressure seals, and

said first and second valving means engaging the respective covers for successively opening said first and second entrances.

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U.S. Cl. X.R.

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