Feb. 6, 1951 O. L. STRAUSS 2,540,844

WEB FOLDING MACHINE

Filed Nov. 28, 1947 3 Sheets-Sheet 1

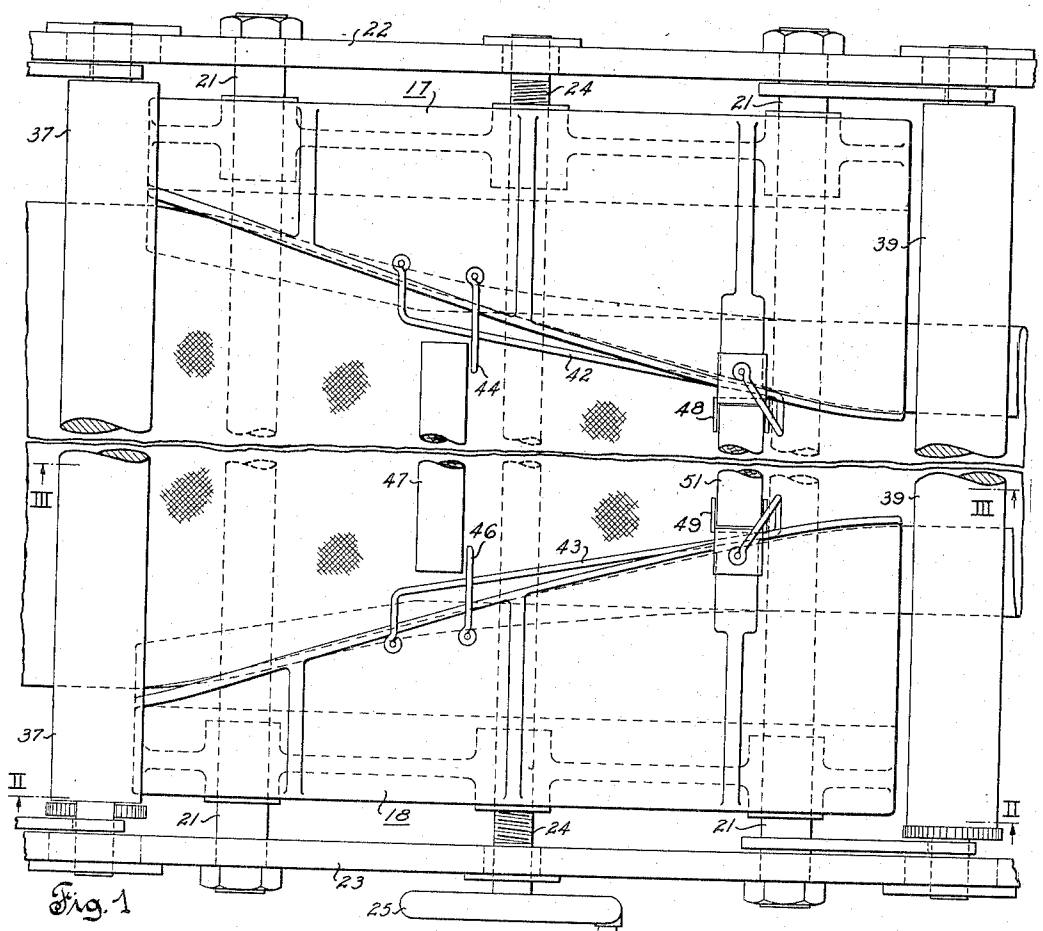

Fig. 1

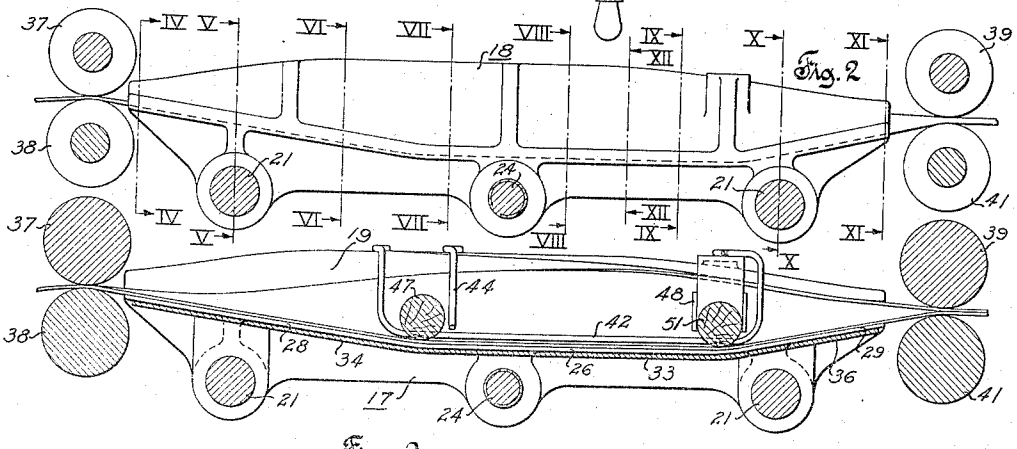

Fig. 2

Fig. 3

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WEB FOLDING MACHINE

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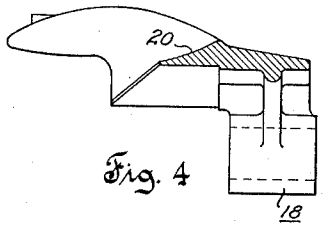

Fig. 4

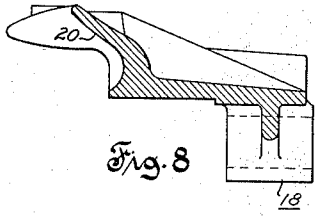

Fig. 8

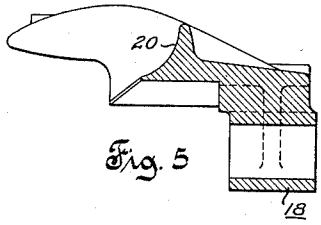

Fig. 5

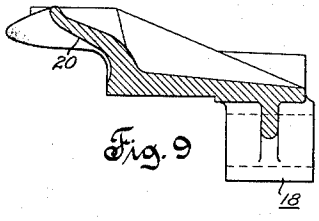

Fig. 9

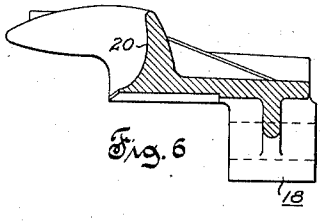

Fig. 6

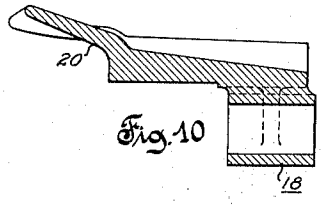

Fig. 10

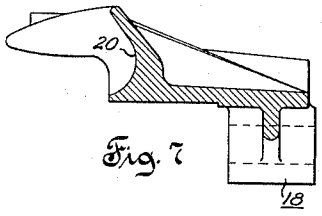

Fig. 7

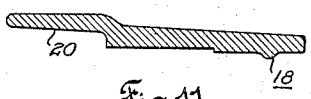

Fig. 11

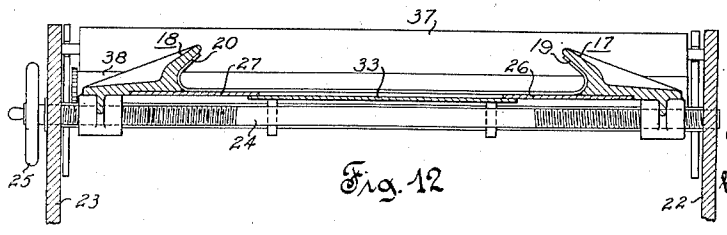

Fig. 12

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WEB FOLDING MACHINE

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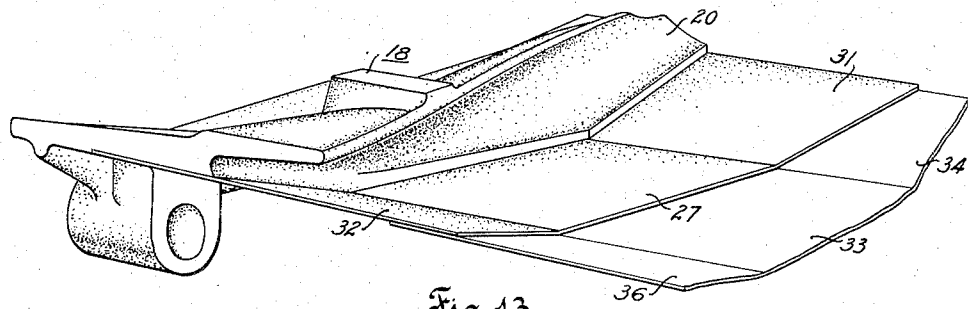

Fig. 13

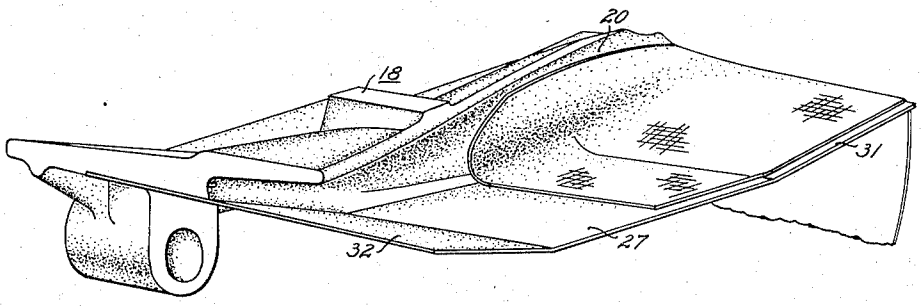

Fig. 14

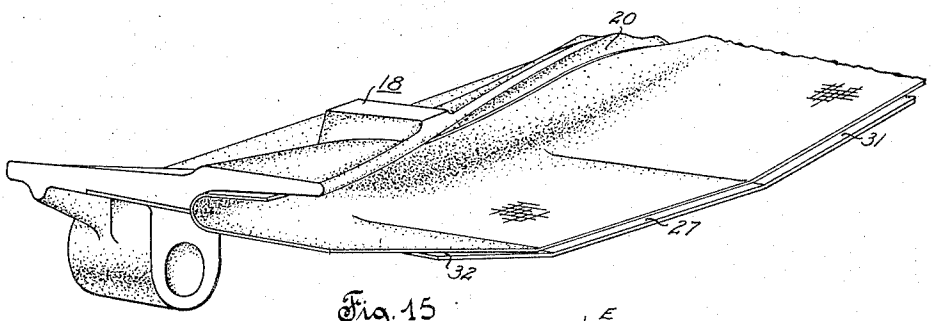

Fig. 15

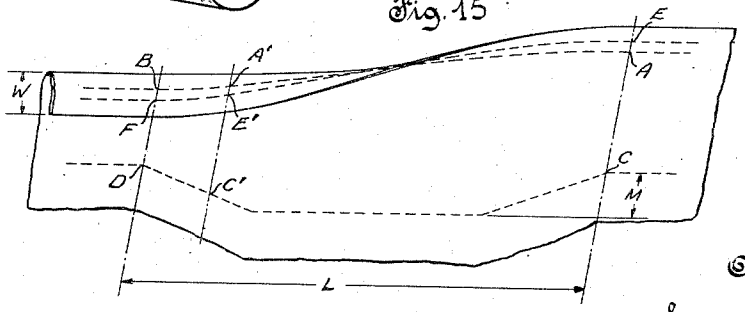

Fig. 16

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Patented Feb. 6, 1951

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UNITED STATES PATENT OFFICE

2,540,844

WEB FOLDING MACHINE

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Application November 28, 1947, Serial No. 788,437

8 Claims. (Cl. 270—93)

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This invention relates in general to folding devices and more particularly to a device for folding continuous sheet material more commonly known as a web.

In experiments on folding material or a web, it has been found that to fold over an edge of sheet material without stretching and smoothing by hand and without placing a strain on the edge of the material or adjoining portions thereof, it is necessary to have a curved surface, which does the folding, of infinite length. As this is impractical, experiments were made to see if a folding device could be made of practical length. Applicant has discovered that if the material, while being acted upon by the folding device, is not supported on a plane surface but is supported on a combination of surfaces which permits the central portion of the material to maintain substantially the same velocity component in the general direction of material movement as the adjoining portions of the material being acted upon by the curved surfaces of the folding device that a folding device of commercially practical length could be achieved.

In the prior art, material has customarily been folded by hand or if mechanically folded, the material was fed by hand to properly guide the material and to maintain the velocity components in the general direction of material movement of the different portions of the material substantially equal. In addition, in the prior art, if it was desired to fold two sides of continuous sheet material, it has been customary to fold one side of the material, fasten down the fold and then fold and fasten down the other side.

An object of this invention is to provide a folding machine which will automatically and smoothly fold over one edge of the mtaerial being fed therethrough without wrinkling, bulging or distorting other portions of the material.

Another object of this invention is to provide a folding device which will automatically operate on one edge of sheet material passing therethrough in a maintained predetermined relation, to produce a smooth fold of uniform width.

Another object of this invention is to provide a folding device which will simultaneously and smoothly fold over two opposite edges of continuous sheet material passing therethrough and produce folds of equal and uniform width or uniform folds of unequal width, providing the center line of the material is maintained parallel to the center line of the device.

More particularly, another object of the invention is to provide an improved folding device wherein all paths traversed by the material in passing therethrough are of substantially equal length. Stated differently, the present invention is directed toward and contemplates the provision of a folding device wherein all parts of the material in passing through any one plane normal

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to the longitudinal center line of the device are then moving in the general direction of travel with substantially equal velocities.

In accordance with this invention, one or more of the previously stated objects may be readily accomplished by utilizing a device wherein one or both edge portions of a sheet of material passing therethrough are folded over without subjecting the material to any stresses tending to produce wrinkles, bulges or distortion thereof.

This invention may be utilized for folding over the edges of any material capable of being folded such as light sheet metal, paper, fabrics and various other materials.

And objects and advantages other than those above set forth will be apparent from the following description when read in connection with the accompanying drawings, illustrating by way of example only, an embodiment of the invention suitable for folding canvas, and in which:

Fig. 1 is a plan view of an embodiment of the present invention;

Fig. 2 is a section view on line II—II of Fig. 1;

Fig. 3 is a section view on line III—III of Fig. 1 with some parts removed for clarity;

Fig. 4 is a partial section view on line IV—IV of Fig. 2 with some parts removed for clarity;

Fig. 5 is a partial section view on line V—V of Fig. 2 with some parts removed for clarity;

Fig. 6 is a partial section view on line VI—VI of Fig. 2 with some parts removed for clarity;

Fig. 7 is a partial section view on line VII—VII of Fig. 2 with some parts removed for clarity;

Fig. 8 is a partial section view on line VIII—VIII of Fig. 2 with some parts removed for clarity;

Fig. 9 is a partial section view on line IX—IX of Fig. 2 with some parts removed for clarity;

Fig. 10 is a partial section view on line X—X of Fig. 2 with some parts removed for clarity;

Fig. 11 is a partial section view on line XI—XI of Fig. 2 with some parts removed for clarity;

Fig. 12 is a section view on line XII—XII of Fig. 2 with some parts removed for clarity;

Fig. 13 is a perspective view of one half of the folding device with some parts removed for clarity;

Fig. 14 is the same as Fig. 13 with an additional part removed and with the material shown part way through the embodiment;

Fig. 15 is the same as Fig. 14 with the material shown throughout the embodiment;

Fig. 16 is a diagrammatic perspective view of the material in Fig. 15.

Referring to the drawings, the embodiment of the invention is a machine having two longitudinally extending elongated bilaterally symmetrical side members 17 and 18, respectively, having opposed gradually developing curved surfaces 19 and 20, respectively. Side members 17 and 18 are slidably supported on rod-like members 21 carried by a pair of spaced side walls 22 and 23,

respectively. Side walls 22 and 23 rotatably support an adjusting rod 24 which is threadedly engaged with side members 17 and 18. On one end of adjusting rod 24 is attached an adjusting wheel 25. As indicated in Fig. 1, the ends of rod 24 are oppositely threaded so that when rod 24 is revolved by rotating wheel 25, members 17 and 18 move toward or away from each other depending on the direction of rotation of wheel 25. Attached to the side member 17 is a bottom or material supporting and guiding member consisting of three portions, a horizontal center portion 26 and two end portions 28 and 29 longitudinally joined thereto and extending upwardly therefrom. Attached to the side member 18 is a like bottom or material supporting and guiding member consisting of three portions, a horizontal center portion 27 and two end portions 31 and 32 longitudinally joined thereto and extending upwardly therefrom.

Mounted on rods 21 is an auxiliary bottom or material supporting and guiding member consisting of a horizontal center section 33 and two end portions 34 and 36, longitudinally joined thereto and extending upwardly therefrom. The bottom portions attached to side members 17 and 18 are telescopically arranged with the auxiliary bottom member to slide thereover when the spacing between side members 17 and 18 is varied as is best illustrated in Fig. 12.

Figs. 4 to 11, inclusive, show the gradually developing curved surface 20 in member 18. As indicated in Fig. 4 the curved surface 20 extends upwardly and away from the bottom portion. In Fig. 6 the curved surface 20 in member 18 extends upwardly and in Fig. 11 the curved surface 20 extends inwardly approximately parallel to the bottom portion. The curved surface 19 in member 17 is similar to the curved surface 20 in side member 18 and, in fact, is a mirror image thereof.

Side walls 22 and 23 rotatably support opposite ends of a pair of press rolls 37 and 38 which are positioned adjacent the receiving ends of side members 17 and 18. Press rolls 37 and 38 are biased by means (not shown) to rotate in contact with each other. Feeding rolls 39 and 41, rotatably supported by side walls 22 and 23, are located opposite the discharge end of side members 17 and 18 in material receiving relation thereto. Feeding rolls 39 and 41 are biased by conventional means (not shown) to rotate in contact with each other and are driven in opposite directions by conventional means (not shown). Feeding rolls 39 and 41 have their outer surfaces knurled (not shown) to aid in feeding material therebetween.

Attached to the top portion of side members 17 and 18, respectively, are loop elements 42 and 43. The lower portions of these elements are positioned proximate to center sections 26 and 27, respectively. The function of loop elements 42 and 43 is primarily to aid in initially threading the material through the folding device to the feed rolls prior to automatic operation. These loop elements act as guiding means for the material moving into the folding device until the movement of material is controlled by feed rolls 39 and 41, at which time the material no longer contacts these loops and they cease to function.

Attached to the top portion of side members 17 and 18 are stop members 44 and 46. These stop members curve down from the top positions of 17 and 18 to points proximate to the center portion of the folding device. A roll 47 is supported on bottom members 26 and 27 and is prevented from moving forward, when the machine is operating, by these stop members but roll 47 may rotate in position. Retaining members 48 and 49 are mounted on the top portion of side members 17 and 18, respectively and extend downwardly therefrom to position proximate to floor member 26 and 27. A roll 51 is retained between side elements of retaining members 48 and 49. Roll 51 is supported by floor member 26 and 27 and is prevented from moving forwardly or rearwardly by these retaining members, but roll 51 is free to rotate. As can be seen from Fig. 3, roll 47 is located along a line formed by the junction of surfaces 28 and 26 while roll 51 is located along a line formed by the junction of surfaces 26 and 29. And in the operation of the folding device these rolls are supported on the material as it passes through the folding device and the weight of these two rolls causes the material not acted upon by side member 17 and 18 generally to follow the configuration of bottom members 28, 26 and 29 as the material passes through the folding device.

The operation of the folding device is as follows: Adjusting wheel 25 is rotated in the proper direction until the spacing between side members 17 and 18 is correct for the width of the material to be folded. Continuous sheet material is introduced between press rolls 37 and 38. The press rolls straighten out the material and cause the material to lie flat prior to entering the folding device. As the material enters the folding device, the outer edges of the material contact the gradual curving surfaces 19 and 20, respectively, of the side members 17 and 18 and as the material is drawn along and between members 17 and 18 the portions of the material in contact with the curved surfaces are gradually successively curved outwardly, upwardly and inwardly with respect to the center line of the material until the edges are folded back on the material. While the end portions of the material are contacting the curved portions of members 17 and 18 the center portion of the material not in contact with the curved surfaces, goes down the inclined surface formed by end portions 28, 34 and 31, over the surface formed by center portions 26, 33 and 27 and up the inclined surface formed by end bottom portions 29, 36 and 32. As the folded material emerges from the folding device, it is gripped between the power driven feeding rolls 39 and 41 which draw the material through the folding device with a predetermined speed and tension. After the material is guided through the folding device to the feed rolls by hand, the folding process is then automatic. To insure that the center portion of the material generally follows the configuration of the bottom of the folding device, rolls 47 and 51 are placed on top of the material and in position to be retained there by stop members 44 and 46 and by retaining members 48 and 49. The forward motion of the material causes the rolls 47 and 51 to revolve against their respective stop and retaining members and the weight of the rolls causes the material to follow the general configuration of the three planed bottom.

If the material being folded is quite flexible, the rolls 47 and 51 can be eliminated as the more flexible materials will follow the configuration of the bottom without any assistance. In fact, with some materials it is possible to operate the folding device without any bottom member. For example, if the side members 17 and 18 were

mounted in a vertical position, the center portion of the material passing between members 17 and 18 would naturally assume a configuration such as is achieved by the present bottom.

And if the folding elements 17 and 18 were mounted upside down, no bottom member would be required but the stop and retaining elements would then have to be spring biased to maintain the rolls 47 and 51 in proper location against the weight of the material being folded.

If it is desired to fold over only one edge of sheet material, then by properly drawing the material through the folding device so that only one edge thereof contacts a curved surface such as surface 20 in side member 18, a fold of one edge can be secured.

The correlation between the bottom members and the curved surfaces in the folding device is such that a portion of the material being acted upon by the curved surface of members 17 or 18 traverses the same distance in passing through the folding device as a center portion of the material does in passing over the three planed bottom portion.

Reference is had to Fig. 16, which is a representation of a portion of the material as acted upon by the folding device and is partly diagrammatic to indicate the path followed by the material that does not contact the curved portions of the side members.

Point A in the material as it moves through the folding device follows the configuration of the curved portion of the side member as indicated by the dotted line path AB. Point C in the material, as it moves through the folding device, follows the configuration of the bottom members as indicated by the path CD. And the distance of path AB is equal to the distance of path CD. This is true for all development lines in the material which are parallel to an edge of the material prior to the material entering the folding device. As for example, total distance EF as measured along the curved path on which it lies is equal to AB and CD. By having all lines of development equal, strain on the edges of the material or adjoining portions is avoided and also a tendency for the material to jam in the folding device. In addition, having the lines of development of equal length results in uniform folds providing the center line of the material is maintained over the center line of the folder.

Fig. 16 also indicates the only practical manner known for constructing a folding device utilizing this invention and is as follows: Take material which is to be folded and make a fold in one end of the desired width, such as fold W. Rigidly fasten this fold and the remaining material to a support along a line BFD. Arrange the center portion of the material to a contour similar to the path CD and arrange the edge of the material in a smooth curved surface emanating from fold W. Then at a point where the curved surface ends fasten the material down along a line, such as line EAC. The material should now have a configuration similar to that shown in Fig. 16 and if the material is sufficiently rigid it can be used as a model. If the material is very flexible and therefore unsuitable as a model, it may be sprayed with shellac and when hard may be used as a model from which measurements can be taken to construct patterns for a folding device. As the curved portions of side members 17 and 18 are mirror images of each other, it is unnecessary to build models for each.

While no formula has been discovered to set forth exactly the relationship between L, the length of the folding device, W, the width of the fold, and M, the drop in the material which does not contact the curved portions of the folding device, there is a relationship between these three dimensions. For example, if the fold W were doubled then L and M would have to be increased to keep the lines of development all of the same length and to prevent the curvatures in the side members from being too sharp.

With this folding device, if a plane is passed through line EAC normal to the general direction of material movement, then in a given time the points E, A and C will have moved to positions E', A' and C' and these points will lie in a plane normal to the general direction of material movement. In other words, all portions of material lying in a plane normal to the general direction of material movement have approximately the same velocity components in the general direction of material movement.

It should be understood that it is not desired to limit the present invention to the exact details of construction and mode of operation or the particular application herein shown and described for the purpose of illustration, since various modifications within the scope of the claims may occur to persons skilled in the art.

It is claimed and desired to secure by Letters Patent:

1. In a device for folding opposite edges of a web over against the same surface thereof, said device having a pair of longitudinally extending transversely spaced side members presenting opposed curved web working surfaces, the improvement comprising web guiding means combined with said side members for coaction in a manner operative to cause that portion of the web intermediate said side members to travel through the device in a path presenting said same surface of said portion in concave relation to a plane common to the web entering and leaving the device, said path being of such concavity that said intermediate portion of said web in passing through the device traverses a distance substantially equal to the distance traveled by portions of the web which contact said working surfaces.

2. A device for folding opposite edges of a web over against the same surface thereof comprising an elongated generally longitudinally extending member presenting a concave web guiding surface extending from the web entering end to the web exit end of the device, said surface being concave in the general direction of web movement and being concave relative to a longitudinal plane common to the web as it enters and leaves the device, a pair of opposed longitudinally extending web folding members positioned adjacent the longitudinal sides of said concave member, each folding member including a web working surface which at the web entrance end thereof diverges from said concave surface and which at the folded web exit end extends substantially parallel in spaced overlying relation to said concave surface.

3. In a device for folding opposite edges of a web over against the same surface thereof, said device having a pair of longitudinally extending transversely spaced side members presenting opposed curved web working surfaces, the improvement comprising web guiding means combined with said side members for coaction in a manner operative to cause that portion of the web inter-

mediate said side members to travel through the device in a path presenting said same surface of said portion in concave relation to a plane common to the web entering and leaving the device, said path being concave in the general direction of web movement and being concave substantially the length of said device, said path being of such concavity that said intermediate portion of said web in passing through the device traverses a distance substantially equal to the distance traveled by portions of the web which contact said working surfaces.

4. In a device for folding an edge portion of a web traveling therethrough over against one surface thereof, said device including a longitudinally extending side member presenting a curved web working surface, the improvement comprising a web guiding means combined with said side member for coaction in a manner operative to cause that portion of the web extending away from said side member intermediate the ends thereof to traverse a path presenting said one surface in concave relation to a plane common to the portions of the web entering and leaving the device, said path being of such concavity that said intermediate portion of the web traverses a distance substantially equal to the distance traveled by the portions of the web which contact said working surface.

5. In a device for folding an edge portion of a web traveling therethrough over against one surface thereof, said device including a longitudinally extending side member presenting a curved web working surface, the improvement comprising web guiding means disposed adjacent said side member in position to direct that portion of the web extending away from said side member intermediate the ends thereof through the device in a path presenting said one surface in concave relation to a plane common to the portions entering and leaving the device, said guide means including longitudinally spaced surfaces diverging respectively away from and toward the web entering and leaving ends of said device so that all portions of the web in said device have substantially equal velocity components in the general direction of web movement.

6. In a machine including means for feeding a web therethrough under a predetermined tension, a device for folding opposite edges of the web over on the same surface comprising a pair of longitudinally extending elongated members disposed in transversely spaced, opposite edge working relation with respect to the web passing therebetween, a generally longitudinally extending web supporting and guiding member positioned intermediate said elongated members, said guiding member including a mid-portion positioned parallel to and in spaced underlying relation to a plane common to the web entering and leaving the device, said guiding member including end portions longitudinally joined to said mid-portion and extending upwardly therefrom to the web entering and leaving ends of said device, said elongated members having web working surfaces extending inward toward each other in spaced overlying relation to said guiding member, and a pair of longitudinally spaced transversely extending members rotatably positioned in contact with the web so that the web passing over said guiding member is directed to follow generally the configuration of said guiding member so that all portions of the web passing in contact with said guiding member have the same velocity component in the general direction of web movement as portions of the web which contact said elongated members.

7. In a machine including means for feeding a web therethrough under a predetermined tension, a folding device comprising a pair of longitudinally extending elongated members disposed in laterally spaced opposite edge working relation with respect to said web passing therebetween, a web supporting and guiding member positioned intermediate and in underlying relation to said elongated members, said guiding member including a mid-portion positioned parallel to a plane common to the web entering and leaving the device, said guiding member having end portions thereof disposed in different planes and extending from the longitudinal ends of said mid-portion upwardly to the ends of said elongated members, said elongated members having opposed web working surfaces extending inward toward each other in progressively developing overlapping spaced relation with respect to said guiding surface, and a pair of longitudinally spaced roller members rotatably positioned in contact with the web by said elongated members so that the web passing over said guiding member is directed to follow generally the configuration of said guiding member and so that all paths followed by portions of the web in traversing the folding device are substantially of equal length.

8. In a machine including means for feeding a web therethrough under a predetermined tension, a device for folding opposite edges of the web over against the same surface thereof, said device having a pair of longitudinally extending transversely spaced side members disposed in opposite edge working relation with respect to the web passing therebetween, the improvement comprising web guiding means combined with said side members for coaction in a manner operative to cause that portion of the web intermediate said side members to travel through the device in a path presenting said same surface of said portion in concave relation to a plane common to the web entering and leaving the device, said side members having opposed web working surfaces extending inward toward each other in progressively developing overlapping spaced relation with respect to said guiding means, and a pair of longitudinally spaced transversely extending roller members positioned in contact with said same surface by said side members so that the portion of the web passing over said guiding means is directed to follow generally the concave configuration of said guiding means and thereby provide all portions of the web passing in contact with said side members and said guiding means with paths of equal length through said device.

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