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2,579,746

MACHINE FOR FOLDING LIMP, FLAT ARTICLES

Filed Nov. 23, 1946

3 Sheets-Sheet 1

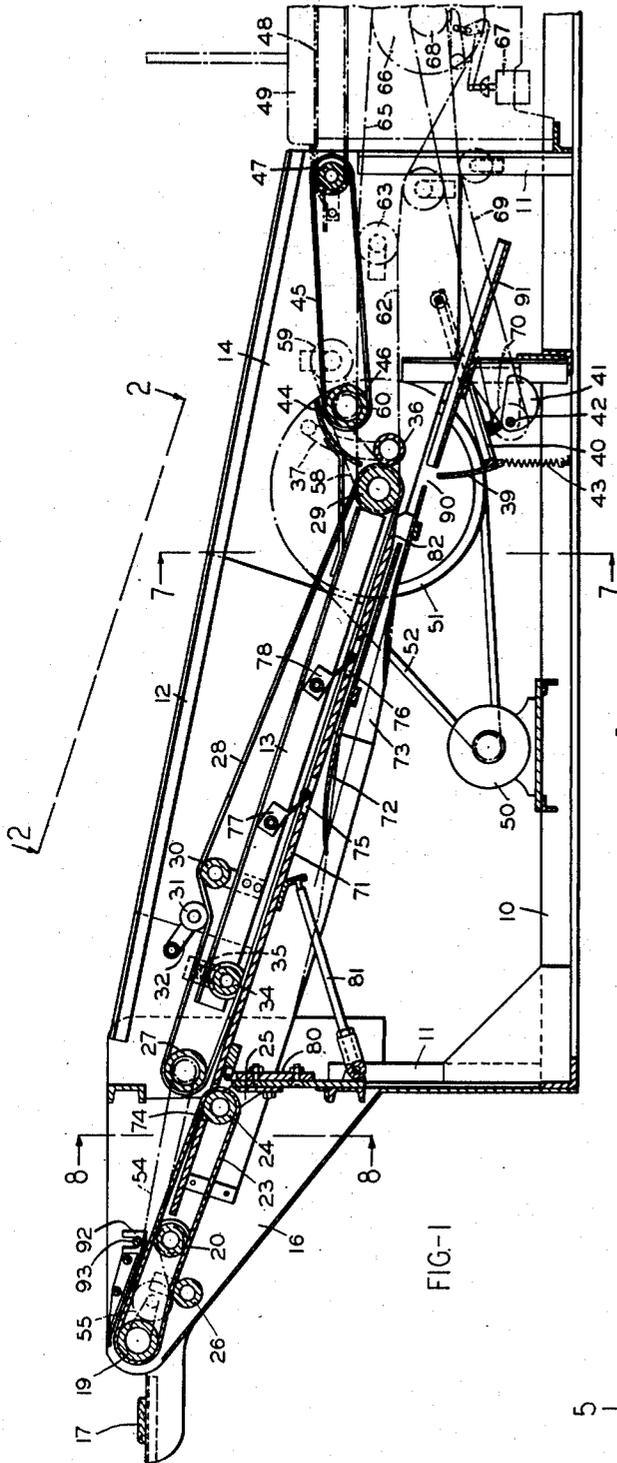


FIG-1

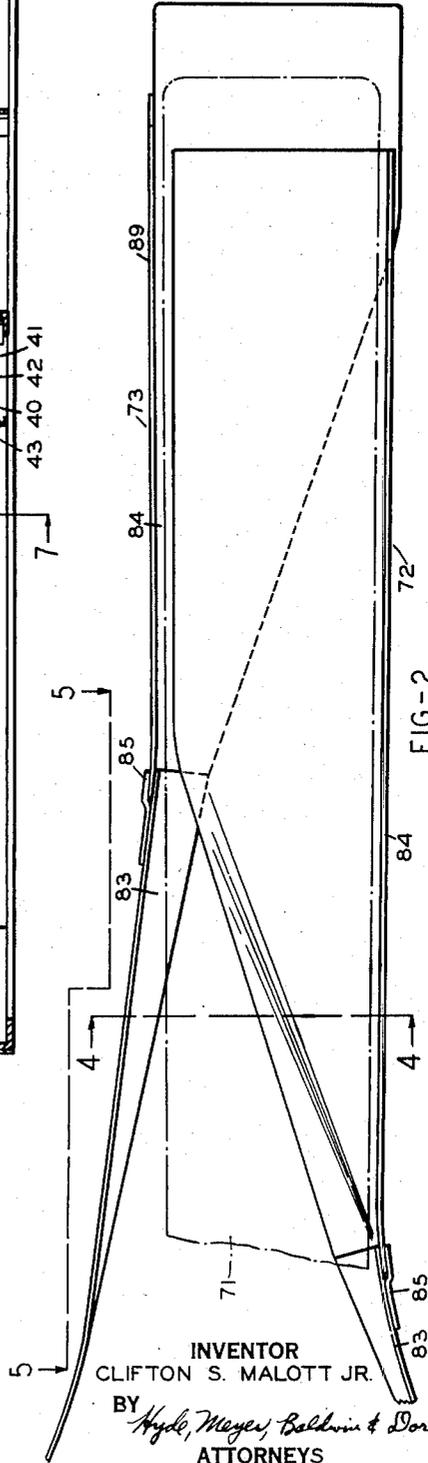


FIG-2

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3 Sheets-Sheet 2

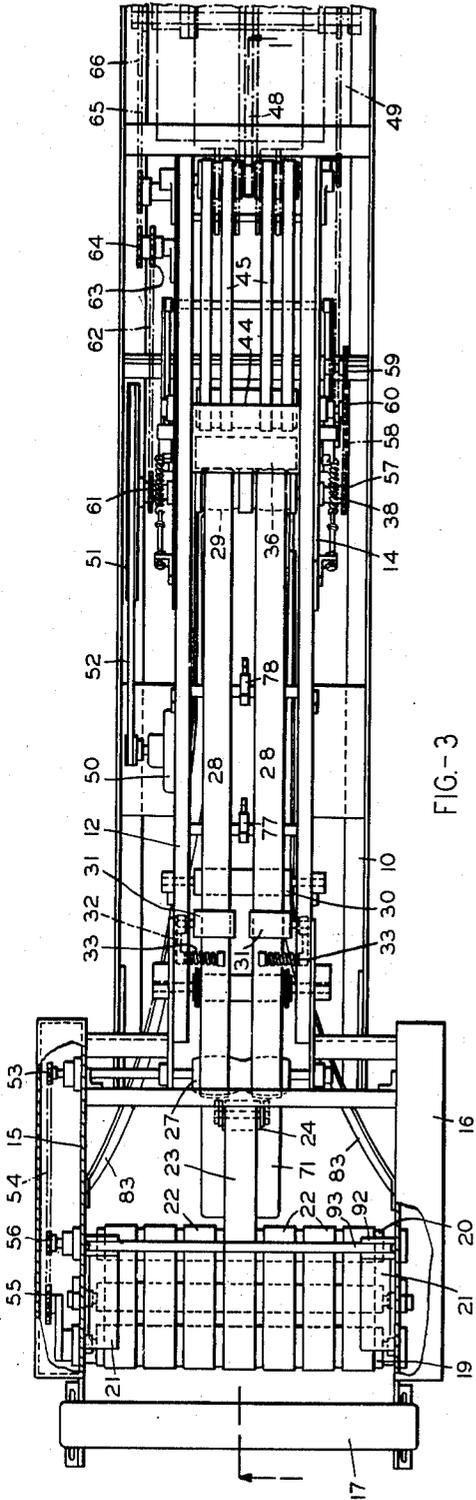


FIG-3

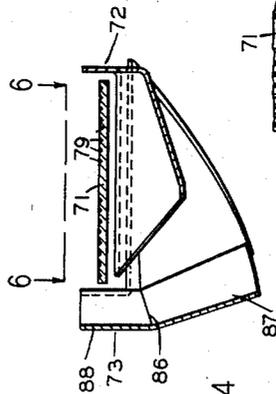


FIG-4

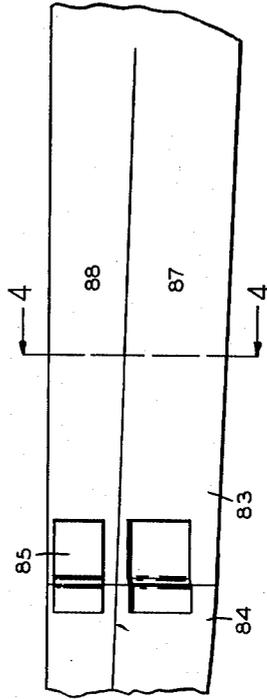


FIG-5



FIG-6

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3 Sheets-Sheet 3

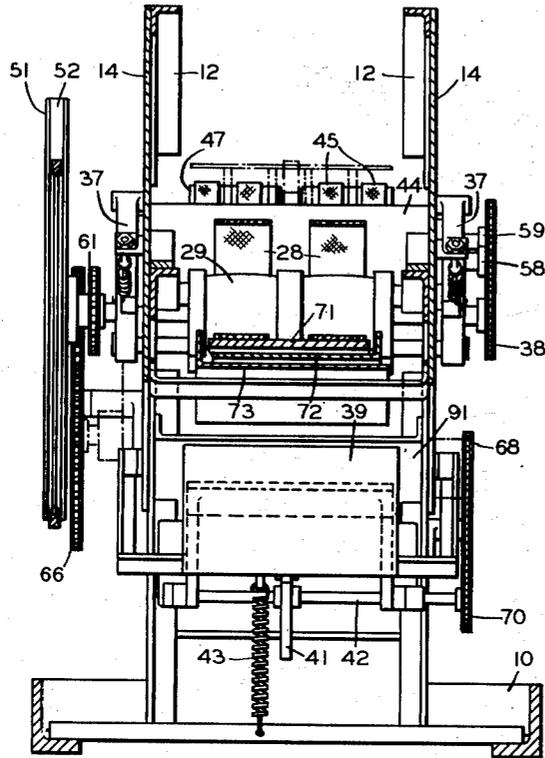


FIG.-7

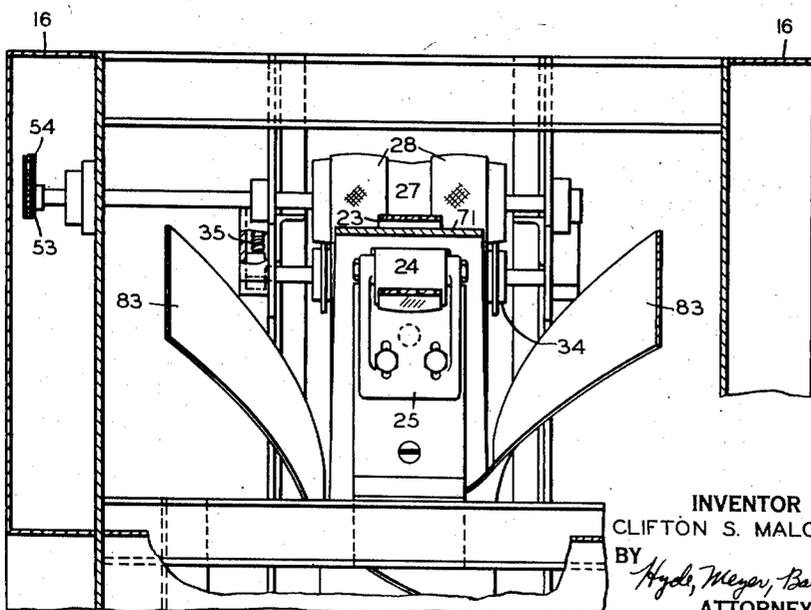


FIG-8

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# UNITED STATES PATENT OFFICE

2,579,746

## MACHINE FOR FOLDING LIMP, FLAT ARTICLES

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4 Claims. (Cl. 270-66)

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This invention relates to folding machines, such as are used in folding flat limp articles, e. g., towels, napkins, pillowcases or the like. The invention has more particular relation to that class of folding machines which utilizes motion of the article along a path for producing longitudinal folds therein.

One object of the present invention is to provide improved method and apparatus by means of which the side edge portions of the advancing article are folded down and under the central portion, instead of up and over it, as heretofore, thereby taking advantage of gravity instead of attempting to overcome its bad effects, and securing more even and accurate folds by simpler and more efficient mechanism.

Another object is to generally improve and simplify the mechanism, including both the article moving devices and the guides which cause it to fold into the desired shape, as well as the driving and operating parts.

Another object is to provide an improved folding machine which is dependable in operation, which not only produces the desired longitudinal folds but also a cross fold or folds and which machine may be so timed and operated as to enable it to operate harmoniously or synchronously with a suitable stacking mechanism, as will later appear.

Further objects of the invention in part are obvious and in part will appear more in detail hereinafter.

In the drawings, which represent one suitable embodiment of the invention, chosen solely for purposes of illustration and not in any sense of limitation,

Fig. 1 represents a longitudinal sectional elevation on the line 1-1, Fig. 3;

Fig. 2 is a plan view taken on the line 2-2, Fig. 1, showing the folding plate assembly only;

Fig. 3 is a plan view of the entire machine;

Fig. 4 is a detail cross section on the line 4-4, Fig. 2;

Fig. 5 is a side elevation of the lower, or left-hand, guide plate and turning plate in the zone indicated by the line 5-5, Fig. 2;

Fig. 6 is a fragmentary plan view of the folding plate only, on the line 6-6, Fig. 4;

Fig. 7 is a cross section on the line 7-7, Fig. 1; and

Fig. 8 is a cross section on the line 8-8, Fig. 1.

The folding machine shown includes a suitable frame, an article moving or conveying system, a set of plates and wings for supporting, guiding and turning the side portions of the moving arti-

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cle, and cross folding devices, all associated in cooperative relation with each other and with a stacking machine shown more or less conventionally. These will be described in about the order named.

### The frame

This may be of any suitable form. It is shown as comprising a base 10, corner legs or posts 11, longitudinal top angle members 12, central angles 13, body side plates 14, feed end side plates 15, all suitably joined and cross braced by various channels, tie rods, plates, roller shafts and other parts to which detailed reference here is unnecessary. Some of these parts will be referred to hereinafter. Housings 16 enclose certain sprockets and bearings, and the frame, at the feed end, supports a shelf or rack 17 to hold a stack or pile of articles to be folded. At the delivery end is located the cooperating stacking machine, before referred to.

### The conveyor system

This includes feed rollers 19, 20, which are a little longer than the widest articles to be folded. Angle plate shields 21, attached to side plates 15, cover the outer ends of the rollers and limit the width of the widest articles that may be fed to the machine. Over the rollers travel several short endless belts 22 (six being shown) and a long belt 23 which at its other end rides on a narrow roller 24 mounted on a bracket 25 (Fig. 1) supported for vertical adjustment on the main frame (Fig. 8). An adjustable roller 26 is provided to take up the slack of all belts.

Beyond and above roller 24 is a roller 27 over which travel two parallel belts 28, spaced one on either side of the center line, riding at their other ends on roller 29. The upper stretch of these belts travels over a long roller 30 and beneath two rollers 31, the latter being mounted on pivoted arms 32 and yieldingly held down by torsion springs 33 for taking up belt slack. The lower stretch travels beneath a yielding hold down roller 34 backed by compression springs 35, the purpose of said roller being to apply pressure to the belts and to the moving article beneath them to insure article advance along the folding plate, as will appear later.

Beyond roller 29 is a roller 36 mounted in arms 37 held by adjustable tension springs 38 (Fig. 3) against roller 29, these two rollers 29, 36 constituting the folding rollers between which the longitudinally folded article is fed for producing a cross fold. The folding blade for so feeding the article is indicated at 39, being mounted upon

pivoted arms 40, for advancement by a cam 41 on shaft 42 and for retraction by spring 43.

Each article fed through the cross folding rollers 29, 36 is led by curved guide 44 to belts 45 traveling over rollers 46, 47, the latter being adjustable. Roller 47 has a section of smaller diameter midway of its length to carry one end of and drive the single belt conveyor 48 of the associated stacker, marked generally 49. This is more or less conventionally shown as of the form illustrated in my copending application for Stacking Device for Folding Machines filed October 19, 1946, Serial No. 704,401, now Patent No. 2,488,674 dated November 22, 1949, to which reference may be had for further information, if desirable or necessary.

The several conveyors are driven as follows:

Motor 50, rotating counterclockwise in Fig. 1, drives sheave 51 on roller 29 by belt 52. Roller 29 thus drives belts 28 and roller 27 on the shaft of which is a sprocket 53 connected by chain 54 to sprocket 55. The lower stretch of chain 54 travels over a sprocket 56 on the shaft of roller 20 which drives belts 22 and roller 19.

At the delivery end of the machine, a sprocket 57 at one end of shaft of roller 29 drives a chain 58 connected to an adjustable sprocket 59, the lower stretch of the chain traveling over sprocket 60 on the shaft of roller 46. A sprocket 61 at the other end of roller 29 drives a chain 62 and sprocket 63, which operates a coaxial sprocket 64 connected by chain 65 to a sprocket 66 in the stacking machine. Through one revolution clutch mechanism controlled by solenoid 67 sprocket 66 drives a sprocket 68 connected by chain 69 to a sprocket 70 on cam shaft 42.

#### *Longitudinal folding devices*

These include an article supporting and forming or folding plate 71 and two side folding wings or plates 72, 73.

Supporting plate 71 is of elongated rectangular form with its side edges parallel, or nearly so. Usually it is tapered slightly in width, being narrower at the front receiving or feed end. The reason for this is that experience showed that a parallel sided plate produced a folded article that tapered, with the trailing end wider than the leading end. Tapering the plate toward the rear of the machine compensates for that tendency and produces a finished article folded to approximately the width of the plate and having parallel side edges.

Plate 71 is provided with three through openings, one, 74, through which roller 24 extends, and two others 75, 76, into which extend the arms or fingers of electrical switches 77, 78, between belts 28, to insure operation of said switches by the moving article. The upper surface of the plate may be provided with longitudinal grooves and ribs, as indicated at 79, Fig. 6, to reduce friction of the moving work upon the plate. Plate 71 is firmly supported, by a frame bracket 80 and an adjustable rod or prop 81 (Fig. 1). Its forward end is beveled to a thin edge at 82.

The right and left turning or folding plates 72, 73 each consist of a receiving and guiding portion or member 83 and a turning member 84 joined together end to end by clips 85, all of the plate members being suitably supported on the frame, or brackets carried thereby. Guide members 83 lie in generally vertical planes and converge in the direction of article movement. They are creased along longitudinal lines 86, with their lower portions 87 twisted and progressively de-

parting inwardly from the vertical, so that they initiate and partially perform the operation of swinging inwardly and upwardly the side portions of the article which hang or are draped downwardly along each side edge of supporting plate 71. The turning or folding members 84 are similarly creased and twisted or bent inwardly and upwardly, in continuation of the guide members, beyond the joints with them, the lower portions being bent up and widened until they form supporting plates below forming plate 71, in planes substantially parallel to it and to each other. The vertical upper portions 88 of plates 72, 73, above the crease, decrease in height until they reach the point indicated by the reference number 89, Fig. 2, where all three plates become parallel. Beyond this point the vertical part, to which reference number 89 is applied, is uniform in height and forms an upstanding side wall parallel to the side edge of the forming plate 71 and spaced from it to permit free passage of the material of the article. A similar upstanding side wall forms a part of plate 73 and continues to its far end. These two upstanding side walls restrict or confine the article closely to the correct width of fold, and with the two side wings supported in superposed relation upon the two plates 72, 73.

It should be understood that the two folding plates 72, 73 have their bends or creases so timed with relation to each other that the turning or folding operation on the two side wings of an article is successive, the right-hand side being turned in and folded up first, with the left wing coming in beneath it, as indicated in Figs. 1, 2 and 4.

As was previously mentioned, the lower portions of the turning plates are substantially parallel to each other and to forming plate 71 when they have made the turn from the vertical. Actually, the upper turning plate 72 is parallel with the lower surface of plate 71, while the lower turning plate 73, after turning, runs up at a slight angle toward the cross folding rollers 29, 36. The end of the plate 71 is tapered off at 82 and terminates a short distance beyond the rear end of plate 72, while plate 73 continues beyond both, to the gap 90 through which the folding blade 39 works (Fig. 1). This arrangement reduces bulk and permits an article to be cross folded with a minimum of sharp bending over plate edges. Beyond the gap 90 is located an inclined pan or table 91 upon which the leading end of an article rides just before the cross folding operation.

The plates 21 at the feed end of the machine have their horizontal portions lying just above the upper surface of the conveyor belts 22. Their purpose is to prevent the operator from feeding an article of excessive width. With a folder plate 71 of given width, these gauge plates 21 are chosen of a size and are so adjusted as to permit an article of maximum width to be folded into three laps or layers of substantially equal width. Narrower articles, of course, are handled without difficulty, the two side lips or wings, of whatever width, being folded under a top layer which is always of fixed width determined by the width of supporting plate 71. Each gauge plate 21 includes or has secured thereto a socket 92 for loosely supporting a removable cross rod 93. The trailing end of an article sometimes whips up as it moves onto and with the pickup conveyor, and rod 93 restrains whipping action and compels the article to ride in flat form upon the conveyor.

## Operation

Towels or other articles to be folded, piled upon shelf 17, are opened up and are fed one by one to conveyor belts 22, upon which they are spread out by the operator. Beyond the roller 20 the article begins to drape by gravity upon the forming plate 71 and long belt 23, its side wings dropping down around and hugging both side edges thereof. One half of the folding movement at each side edge is thus produced entirely by the gravity draping effect, quite independent of folding plates and without resort to any momentum effect due to speed of travel, such as when the side portions are folded upwardly and inwardly, instead of downwardly and then upwardly and inwardly, as here. The discharge end of belt 23 rides upon the short roller 24, which projects slightly above the upper surface of plate 71 through the opening 74 therein. The advancing article travels along the upper surface of plate 71, said surface being grooved to provide easy slide, and as frictionally gripped and held down upon the plate by the under surface of belts 28, beneath which the article moves. Spring bias roller 34 presses the belts lightly but positively against the article and insures its longitudinal travel. From the roller 34 the belts 28 (which normally are held in light contact with plate 71) continue to advance the article by frictional contact therewith. It should be understood, in this connection, that in the drawings, the vertical spaces between the several plates 71, 72, 73, as well as the thickness of the plates themselves, have all been exaggerated in Fig. 1 for clearness of illustration.

As the article advances it right-hand depending wing portion (viewing the machine from the feed end) contacts the right-hand guide plate 72 and is progressively folded inwardly and upwardly under plate 71, in the manner described. Similarly, before the right-hand wing is quite fully folded, the left-hand draped wing has contacted the left-hand guide plate 73 and is progressively folded inwardly and upwardly under plate 72. In both cases the limp side wing of the fabric article is lifted positively and is drawn in around the edge of forming plate 71 in such manner as to there produce and hold a close, definite fold line, and without any possibility of forming or permitting the formation of slack and consequent wrinkles in the wing being folded. Each article is firmly supported throughout the entire area of both its center and side wing portions from the moment when it first engages forming plate 72 until it is engaged by both the cross folding blade 39.

As the article advances along plate 71 it successively trips switches 77, 78, which actuate or control an electronic timer of conventional time delay type (not shown) sensitive to the length of the actuating articles in relation to article movement. This timer ultimately produces actuation of the solenoid 67 controlling operation of both the stacking machine 49 and the cross folding blade 39, as will appear. The article continues to advance and, leaving lower turning plate 73, it crosses the gap 90 and slides onto pan 91. When the longitudinally folded article has advanced such a distance that the mid point of its length is opposite the gap 90, the electronic timer, through a circuit not shown, energizes solenoid 67, producing one complete operation of the stacking machine, and one revolution of shaft 42 in the folding machine. The revolution of this shaft elevates arms 40 and advances

the folder blade 39 through the gap 90, into the bite between the folding rollers 29, 36. As the article emerges from said rollers it is guided by plate 44 onto the top run of conveyor belts 45 which convey the article to belt 48, with which it moves into stacking position. Any article thus delivered into the stacker, by its conveyor belt 48, is subsequently stacked at the same time a following article actuates the timer and thereby is cross folded, as before explained.

The folding apparatus described is of relatively simple construction, operates satisfactorily, and folds a series of articles of generally similar size and shape, so that they are of uniform dimensions and can be stacked into a neat symmetrical pile. Gravity is utilized to assist in rather than to hinder the longitudinal folding operation, and much of the usual complexity of control and operation is eliminated. The machine is entirely automatic, requiring only the feed to it in succession of articles to be folded.

Other advantages of the invention will be apparent to those skilled in the art.

What I claim is:

1. Folding apparatus of the character described for folding a limp, flat article, comprising an elongated thin flat supporting plate having opposite generally parallel longitudinally extending side edges and upon the upper surface of which a portion of the limp flat article may be supported in horizontal position with two side wings thereof each depending from a longitudinal line of fold extending along one of said edges, means for advancing said article along said supporting plate, and two stationary folding members comprising a first and a second folding plate each spaced from a respective side edge of the supporting plate, and each having a folding portion of twisted form which progressively changes from depending vertical disposition at its front article-receiving end to horizontal disposition at its rear end, the said first folding plate near said rear end being spaced immediately below and parallel to the rear end portion of said supporting plate, and the said second folding plate near its rear end being spaced immediately below said first folding plate, and parallel both to the rear end portion of said first folding plate and the rear end portion of said supporting plate, the twisted portion of the first said folding plate beginning at a point in advance of that of the second said folding plate, whereby the depending side wings of an article advanced along said supporting plate are successively and progressively folded inwardly and upwardly along fold lines adjacent the said side edges of said supporting plate, and during the entire operation are firmly supported throughout their entire area.

2. Folding apparatus of the character defined in claim 1, and wherein the means for advancing said article along said supporting plate comprises an endless work-advancing belt located entirely above said supporting plate and having its lower stretch extending longitudinally along the upper surface of said supporting plate, and means for holding the belt yieldingly down upon the supporting plate, and thereby advancing along said supporting plate an article inserted between said belt and said supporting plate.

3. Folding apparatus of the character described for folding a limp, flat article, comprising an elongated thin flat supporting plate having opposite generally parallel longitudinally ex-

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tending side edges, and upon the upper surface of which a central longitudinal portion of the limp flat article may be supported in horizontal position with two side wings thereof each depending from a longitudinal line of fold extending along and adjacent to said side edges, means for advancing said article along said supporting plate comprising an endless work-advancing belt located entirely above said supporting plate and having its lower stretch extending longitudinally along the upper surface of said supporting plate, means for holding the belt yieldingly down upon the supporting plate comprising a yieldable cross roller lying above said lower belt stretch and arranged to apply pressure through it to an article travelling along said supporting plate, and thereby adapted to advance said article along said supporting plate, and two stationary folding members comprising a first and a second folding plate each spaced from a respective side edge of the supporting plate and each having a folding portion of twisted form which progressively changes from depending vertical position at its front article-receiving end to horizontal disposition at its rear end, the said first holding plate near its said rear end being spaced immediately below and parallel to the rear portion of said supporting plate, and the said second folding plate near its rear end being spaced immediately below said first folding plate, and parallel both to the rear end portion of said first folding plate and the rear end portion of said

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supporting plate, the twisted portion of the first said folding plate beginning at a point in advance of that of the second said folding plate, whereby the depending side edges of an article advanced along said supporting plate are successively and progressively folded inwardly and upwardly along fold lines adjacent the said side edges of said supporting plate, and during the entire operation are firmly supported throughout their entire area.

4. Folding apparatus as defined in claim 1, and comprising, in combination therewith, cross folding devices located above and beyond the discharge end of said supporting plate, and movable means disposed below and beyond said discharge end and adapted to be moved upwardly for elevating the longitudinally folded article and delivering it to said cross folding devices.

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