

Nov. 8, 1949

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2,487,494

METHOD OF FOLDING PLASTIC SHEET MATERIAL

Filed Feb. 6, 1947

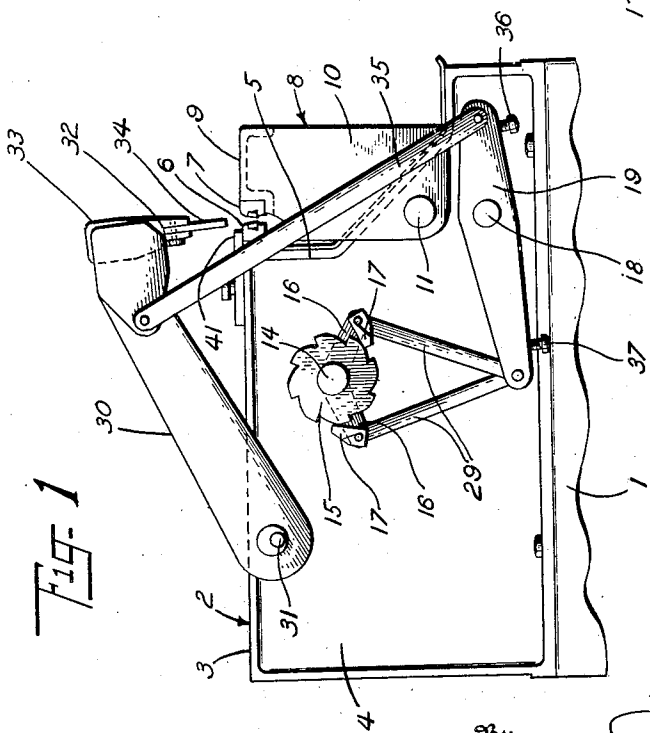
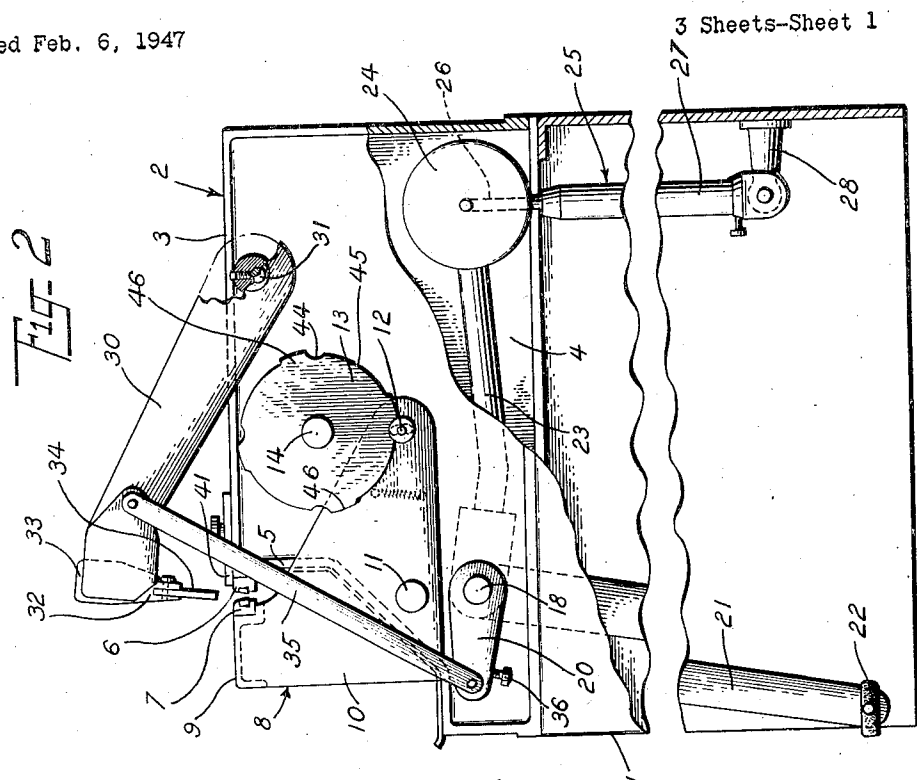


Fig. 12

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3 Sheets-Sheet 2

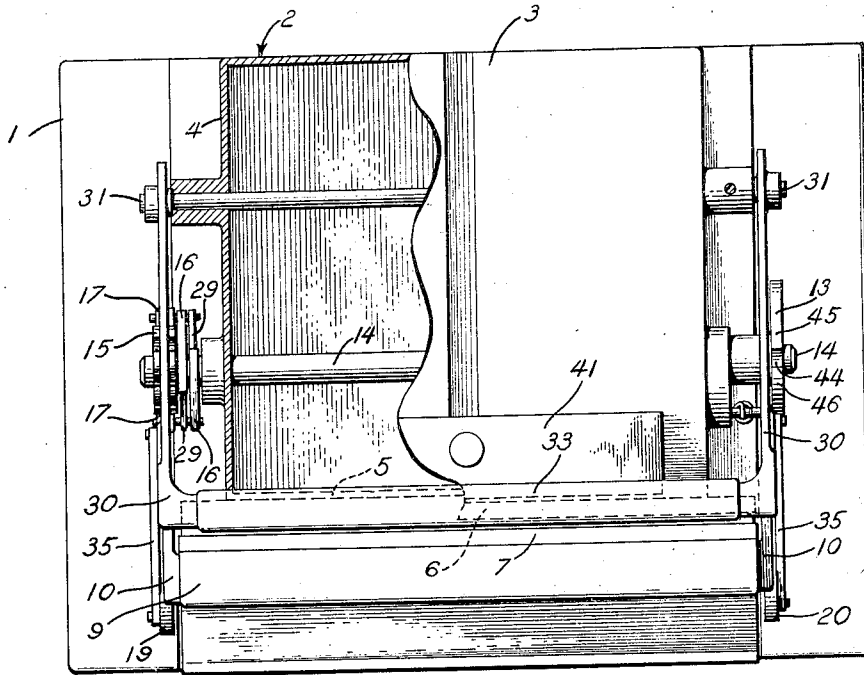


Fig- 3

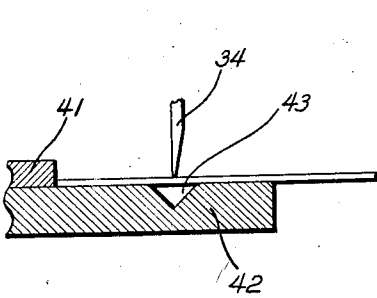


Fig- 4

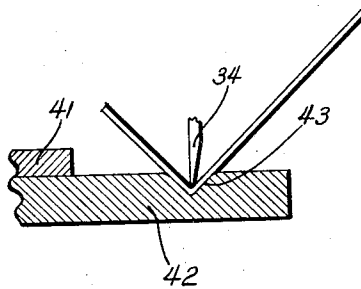


Fig- 5

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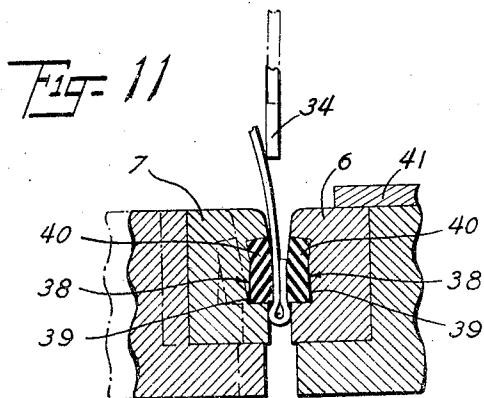
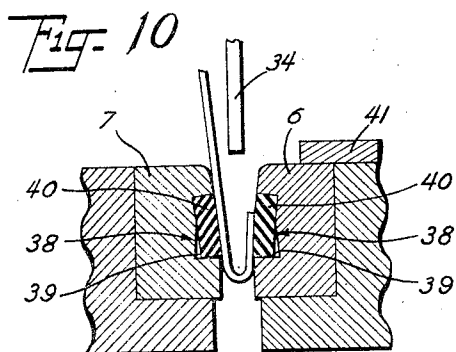
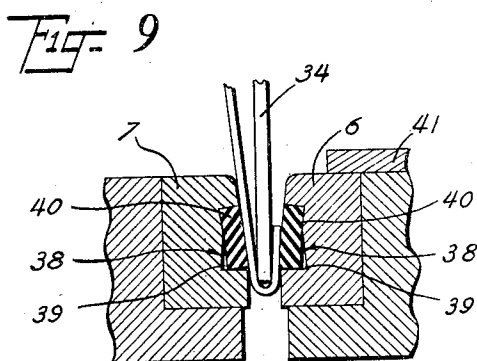
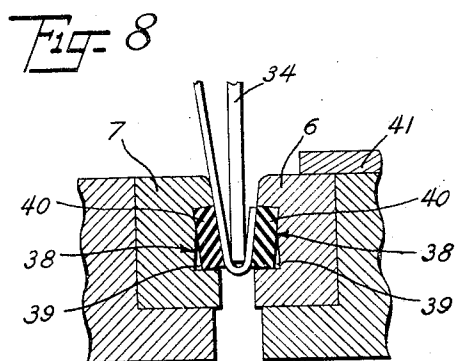
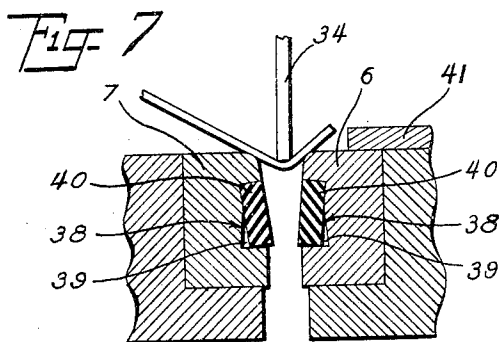
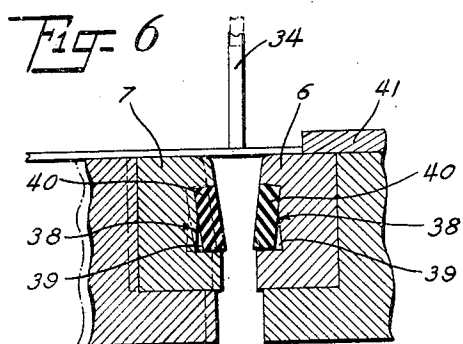
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METHOD OF FOLDING PLASTIC SHEET MATERIAL

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4 Claims. (Cl. 18-56)

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This invention relates to a method for forming permanent folds in plastic sheet material.

The invention provides an economical and rapid method of forming folds in plastic sheet material with the use of heat for softening the plastic material in the portion being folded so that it will be folded into a permanent bend for thereafter effectively retaining its shape.

With the present method, a plastic sheet to be folded is placed in position for support on a pair of spaced parallel ledges. Then, a heated folding blade is moved to engage the edge with the portion of the sheet between the ledges. The blade is then moved to bend the sheet about the blade between the ledges with sufficient slowness in movement of the blade to allow the heat to soften the material at the portions engaged with the blade. The sheet material becomes readily folded to provide a bend portion at the blade that will take a permanent set after removal of the heated blade therefrom. With this method, a permanent fold of any degree may be made in plastic material. Where it is desired to have the portions of the sheet on opposite sides of the fold lie in substantial contact with one another, the invention provides for movement of the spaced parallel supporting portions or ledges, in the form of supporting bars, toward one another. This moves the ends of the sheet at opposite sides of the blade extending from the fold portion engaging the corners of the heated forming blade into adjacent but spaced relation to the sides of the forming blade. Then, the forming blade is withdrawn while the folded sheet is held between the bars. The bars are moved closer together after withdrawal of the blade from the fold to bend the fold portion of the sheet to bring and hold the portions at opposite sides of the fold in close contact while at the same time absorbing the heat in the plastic sheet to cool and set the bend therein.

In the drawings:

Fig. 1 shows in substantially diagrammatic form the left-hand upper side portions of a machine to form folds in plastic sheet material according to the method of the invention.

Fig. 2 is a substantially diagrammatic view showing the right-hand side of the machine, with portions broken away for convenience in illustration.

Fig. 3 is a plan view of the machine, as shown in Figs. 1 and 2, with portions broken away and shown in section to illustrate some of the details of construction.

Fig. 4 is an enlarged diagrammatic cross-section

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tion with a portion of a sheet in position ready to be folded according to the invention.

Fig. 5 is a diagrammatic cross-section showing how the folding blade illustrated in Fig. 4 is moved to fold the sheet with the ends extending at right angles from the fold portion in accordance with the invention.

Fig. 6 is a fragmentary cross-section showing how the folding blade is moved into position to engage a sheet to be folded in its supported position on a pair of spaced parallel fold forming bars providing spaced ledges between which the sheet is bent in the folding operation.

Fig. 7 shows a cross-section similar to Fig. 6 with the folding blade moved into a position between the fold forming bars to bend the sheet to be folded with the ends at opposite sides of the folding blade extending substantially at right angles.

Fig. 8 shows how the folding blade is moved from the position of Fig. 7 downwardly an additional amount between the fold forming bars, illustrating another step in the operation of forming a tight fold in a plastic sheet.

Fig. 9 illustrates a further operation progressing from Fig. 8 in the folding of a sheet to provide a tight fold therein, with the blade at the bottom of its stroke of movement.

Fig. 10 is a view similar to Fig. 9 showing still another progressive position in forming a fold in a sheet wherein the parallel forming bars are in the same position as shown in Figs. 8 and 9, while the folding blade has been partially removed from the fold in the sheet which remains in position between the bars, as shown in Fig. 9.

Fig. 11 illustrates the final folding position of the fold forming bars and the blade in which the blade has been removed from between the bars and the fold in the sheet while the bars have been moved closer together to bring the portions of the sheet at opposite sides of the fold therein into close engagement with one another between the fold forming bars while the bars engage the fold portion of the sheet to absorb the heat therein and set the fold during further movement of the blade away from the bars.

Fig. 12 illustrates a sheet having a finished tight fold formed therein.

The method provided by the present invention is preferably carried out by a suitable machine providing the ledges or fold forming bars and the folding blade so that the ledges or bars may be arranged and maintained at the desired spaced relation and moved toward one another when a tight fold is to be formed, and also to provide for

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the movement of the blade at the desired speed into a predetermined position with respect to the forming ledges or bars to secure the folding of a series of sheets uniformly.

The machine is illustrated in substantially diagrammatic form and will preferably be constructed in accordance with the disclosure in the co-pending application filed on even date herewith entitled "Plastic sheet folding machine."

The machine has a suitable base 1 carrying a rigid supporting frame 2 formed with a flat sheet supporting top portion 3, depending side walls 4 and front wall portion 5. Front wall portion 5 extends downwardly from the front edge of top portion 3 and has a downwardly and forwardly inclined portion terminating in a horizontal forwardly extending portion so arranged that the top portion of rigid supporting frame 2 is offset to the rear of the bottom front portion thereof. At the juncture between front wall portion 5 and sheet supporting top portion 3, the supporting frame is formed with a seat to support a fold-forming bar 6 with the upper face in coplanar relation with top portion 3. A similar fold-forming bar 7 is supported in opposed relation to fold-forming bar 6 on carrier 8 having a sheet-supporting top portion 9 formed with depending side members 10. Side members 10 are located beyond opposite sides of frame 2 and have the lower ends mounted on shaft 11 extending through side walls 4 for rotatably supporting carrier 8 on supporting frame 2.

Side members 10 at the right-hand side of the machine, as shown in Fig. 2, is provided with a rearwardly extending portion carrying an eccentrically mounted roller 12 engaged with the periphery of cam 13 on cam shaft 14. Cam shaft 14 is rotatably mounted in side walls 4 of supporting frame 2. A ratchet wheel 15 is mounted on the opposite end of cam shaft 14 beyond left-hand side wall 4. A pair of pawl-carrying plates 16 are rotatably mounted at one end on cam shaft 14 between ratchet wheel 15 and side wall 4, as shown in Fig. 1, and carry spring-pressed pawls 17 on their free ends arranged to engage the teeth on ratchet wheel 15.

An operating shaft 18 is rotatably mounted at opposite ends in the lower front portions of sides 4 on supporting frame 2. A pair of actuating levers 19 and 20 are mounted on the left and right-hand ends respectively, of shaft 18, as shown in Figs. 1 and 2, while an operating lever 21 has the upper end secured to the central portion thereof between side walls 4 and extends downwardly under the front portion of supporting frame 2. Foot pedals 22 are mounted on the lower end of operating lever 21. Operating lever 21 has a rearwardly extending rod 23 mounted in the upper end thereof, as shown in Fig. 2, carrying a counter-weight 24 on the rear end. A dash pot 25 has the piston rod 26 thereof connected at one end to counter weight 24 and the rear end of rod 23, while the lower end of cylinder 27 is mounted on a suitable bracket 28 carried by base 1.

A pair of links 29 are pivotally secured to the rear end of actuating lever 19, Fig. 1. Each link has its opposite end pivotally connected to the free end of one pawl-carrying plate 16. This provides for the simultaneous movement of both pawl-carrying plates in opposite directions relative to each other about cam shaft 14 whenever actuating lever 19 is moved to operate links 29 in a manner that will be hereinafter described.

A pair of spaced parallel blade-carrying arms

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30 are provided with an eccentric mounting on a blade-supporting shaft 31 extending through supporting frame 2 and rotatably mounted in side walls 4 thereof. Blade-carrying arms 30 are mounted on the free ends of shaft 31 outwardly beyond side walls 4 in the manner clearly shown in Figs. 1 to 3.

Blade-carrying arms 30 extend forwardly and upwardly from shaft 31 to a position above supporting frame 2 at the front portion thereof, where they carry folding blade assembly 32. The folding blade assembly extends transversely between the free upper ends of arms 30 and has a body portion 33 constructed to receive a suitable conventional electric heating element for heating body 33 in order to transmit heat to folding blade 34 with the provision of suitable controls for maintaining a desired uniform heat. Arms 30 mount the folding blade assembly with folding blade 34 positioned to engage between fold-forming bars 6 and 7, respectively. Links 35 are pivotally connected to the forward ends of actuating levers 19 and 20 and at the opposite ends to the respective blade-carrying arms 30, as shown in Figs. 1 and 2. Set screws 36 on the lower forward ends of actuating levers 19 and 20 respectively, are adjusted to engage the upper end of base 1 in the movement of operating lever 21 rearwardly for limiting the extent to which folding blade 34 extends downwardly between fold-forming bars 6 and 7. A set screw 37 is mounted on the rear lower side of actuating lever 19, as shown in Fig. 1 for engaging the upper end of base 1 and limiting the forward movement of operating lever 21 and the upward movement of blade-carrying arms 30 and folding blade 34.

Each fold-forming bar has the side opposed to the other bar formed with a longitudinally extending groove throughout the central portion thereof, indicated at 38. Each groove has bottom portions 39 arranged in angular relation at opposite sides of the grooves so that a resilient strip 40 may have one edge seated and secured in one side of the groove while the opposite edge or margin projects slightly outwardly from the groove at the other side in spaced angular relation to the bottom of the groove, as clearly shown in Figs. 6 to 11. The free edges of resilient strips 40 project outwardly from groove 38 beyond the face of the respective folding bars 6 and 7 to provide resilient gripping cooperation in the opposed relation of bars 6 and 7 to engage opposite sides of a folded sheet and hold it between the bars. The eccentric mounting for arms 30 may be adjusted to vary the position of folding blade 34 relative to bars 6 and 7 depending upon the spaced relation of the bars 6 and 7 obtained by adjusting eccentrically mounted roller 12. These adjustments are made for sheets of varying thickness as well as to change the closeness with which folding bars 6 and 7 are arranged in the different folding positions. By this means the folding operation may be accurately controlled to secure the desired result.

In folding sheets according to the method of the present invention, a plastic sheet of the desired thickness and size is engaged on top portions 9 and 3 respectively, with one edge in contact with the gauge bar 41 to position the portion to be folded in the central portion between bars 6 and 7. Gauge bar 41 is mounted on top portion 3 for adjustment toward and from folding bar 6 so that it may be set for gauging the position of the fold in each sheet to be formed.

If it is desired to form a 90° fold or bend in

a sheet of plastic material, reference to Figs. 4 and 5 illustrates how this may be obtained by moving the sheet up against a gauge bar 41. Figs. 4 and 5 illustrate a forming bar 42 formed with a V-shaped groove or chamber 43 in the upper face thereof. This bar 42 may be substituted for folding bars 6 and 7 where it is desired to form a right-angle bend in the plastic sheet material. In folding a sheet in the use of forming bar 42, it will be understood that it is held in a stationary position with respect to top supporting portion 3 of frame member 2, through rendering spring-pressed pawls 17 inoperative relative to ratchet wheel 15. Bar 42 forms a stationary forming bar for cooperation with heated folding blade 34. Bar 42 provides a pair of ledges in spaced parallel relation on opposite sides of folding blade 34 on which the sheet to be folded will rest and be supported during the folding operation.

The blade is first moved downwardly into engagement with the upper face of the sheet in position on forming bar 42. The nearly sharp edge of the heated folding blade 34 engages the plastic sheet between the spaced parallel ledges and immediately begins to heat the sheet. The blade is then moved downwardly into the V-shaped groove 43 with continued heating of the sheet while it is bent about the blade between the ledges on bar 42. As folding blade 34 is moved downwardly toward the bottom of groove 43 to flex the sheet between the ledges, the heat at the edge of the blade will be absorbed by the plastic sheet material as it is gradually bent downwardly until the bottom of groove 43 is reached, as shown in Fig. 5. This gives the sheet material time to absorb sufficient heat to soften the material so that it will flow into bent or curved relation about the edge of heated blade 34 without stressing the structure of the sheet. Blade 34 is moved downwardly until the lower edge normally engages the sheet in the bottom of V-shaped groove 43 and forming bar 42 so that a right-angle bend in the sheet is formed, as shown in Fig. 5.

In forming the right-angle bend as shown in Figs. 4 and 5, operating lever 21 will be moved from the forward position to rearward position determined by the position of blade 34, as shown in Fig. 5 where it is engaged at the bottom of groove 43. Then the operating lever is released so that counter-weight 24 will move it back to the starting position as shown in Fig. 2, with a decelerated movement governed by dash pot 25. This will give an opportunity for blade 34 to move from the folded portion of the sheet engaged in V-shaped groove 43, as shown in Fig. 5, and allow the heat in the sheet to be absorbed by folding bar 42 so that the plastic material in the sheet will become set in the folded position by the time folding blade 34 reaches its uppermost position whereupon the completed folded sheet is removed from forming bar 42.

If desired, a right-angular bend may be formed in a sheet of plastic material through the use of forming bars 6 and 7. By this method a sheet is inserted against gauge bar 41 so that the portion desired to be folded is placed in the proper position between bars 6 and 7, as shown in Fig. 6. Then, operating lever 21 is moved to bring folded blade 34 downwardly to engage the sheet, as shown in Fig. 6 and bend it downwardly into the chamber between bars 6 and 7 to the position shown in Fig. 7. This method of folding a sheet may be obtained by adjusting screws 36 to limit the movement of actuating levers 19 and 20 so

that the position of blade 34 between bars 6 and 7 is limited to extend downwardly between bars 6 and 7 to no greater extent than that shown in Fig. 7. The sheet is flexed as the folding blade 34 moves from the position shown in Fig. 6 downwardly to the position shown in Fig. 7. As the blade moves from the position of Fig. 6 to that shown in Fig. 7, the sheet will absorb sufficient heat for securing the permanent folding of the sheet with the portions at opposite sides of the blade extending in right-angular relation, the same as that shown in Fig. 5. The blade is held for a short period sufficient to allow the plastic material in the sheet to heat and permanently set the sheet in folded unstressed position, as shown in Fig. 7, whereupon it may be withdrawn and the sheet allowed to remain engaged between bars 6 and 7 until it cools and sets the material.

The invention also provides a method of forming a tight fold in a sheet in the manner shown in Figs. 6 to 11 inclusive. The sheet is first placed against gauge bar 41 so that the portion to be folded is centered in position over bars 6 and 7. Screws 36 are adjusted to control the amount blade 34 extends between bars 6 and 7. Then, folding blade 34 is moved downwardly to engage the sheet in the position shown in Fig. 6. Blade 34 has its downward movement continued to bend the sheet into the position shown in Fig. 7 during which time the heat from the blade is transmitted to the sheet to soften the material thereof so that it will readily fold about the blade. The downward movement of the folding blade is continued from the position shown in Fig. 7, while the carrier with folding bar 7 has been moved inwardly slightly from its initial position by the rotation of cam shaft 14 and cam 13 in a counter-clockwise direction, as shown in Fig. 2. Rotation of cam 13 disengages dwell 44 from roller 12 and moves cam portions 45 into engagement with roller 12 thereby moving bar 7 slightly closer to bar 6. This motion of bar 7 closer to bar 6 is obtained when the parts are in the position shown in Fig. 6 and the position of bar 7, as illustrated in Fig. 7 is the same. Heated blade 34 as shown in Figs. 6 to 11 is square on the edge so that plastic sheets will bend about the blade to engage only the corners. The plastic sheet being folded will be heated in the region engaged with the corners of the blade 34 along opposite side faces.

Heated blade 34 is then moved still farther downwardly between fold forming bars 6 and 7 where a position illustrated in Fig. 8 is reached while the plastic sheet is further heated. Fold forming bars 6 and 7 remain in substantially the same position, as shown in Fig. 7 during this further movement of heated folding blade 34. The movement of blade 34 continues to the position shown in Fig. 9 where the lower edge of the blade extends slightly below the lower edges of channels 38 so that the fold portion in the sheet is located below the lower ends of resilient strips 40.

From the position of Fig. 9, folding blade 34 is gradually withdrawn from the folded sheet between fold forming bars 6 and 7. Fig. 10 illustrates the partial withdrawal of folding blade 34 from the folded sheet held in the same position shown in Fig. 9 between fold forming bars 6 and 7 through the cooperation of resilient strips 40 with the folded sheet.

As folding blade 34 is further withdrawn from engagement with the sheet and from between bars 6 and 7, fold forming bar 7 is moved still

closer to bar 6. Bars 6 and 7 bend the fold portion of the sheet below the resilient strips for moving the portions of the sheet at opposite sides of the fold into close contact with one another, as shown in Fig. 11. During the withdrawal of blade 34 from the fold portion in the sheet, bars 6 and 7 in the position shown in Fig. 11 hold the folded sheet for a sufficient length of time to absorb the heat from the fold portion and adjacent portions thereof to thereby cool the plastic material so that it will permanently set in a tight folded position. The movement of fold forming bars 6 and 7 into the close position shown in Fig. 11 is obtained by a cam lobe 46 on cam 13 engaging roller 12 for rocking carrier 8 in moving bar 7 toward bar 6.

When folding blade 34 reaches the position shown in Fig. 9, operating lever 21 has reached its rearmost position of movement by manual operation so that set screws 36 and 37 engage the frame to limit further movement. Operating lever 21 then moves forwardly under the operation of counter-weight 24 and the control of dash pot 25 at a predetermined slow rate until the starting position shown in Fig. 2 is reached. This slow withdrawal of blade 34 from the fold in the sheet, as shown in Fig. 9, to the position shown in Figs. 10 and 11, secures an efficient timing of the folding operation so that the sheet is fully folded into the tight position with the material in the sheet being formed to follow the direction of the fold so as to maintain a permanent set in the material after it cools.

When blade 34 has reached its starting position and operating lever 21 is in the position shown in Fig. 2, another dwell 44 in cam 13 moves into position to receive roller 12 so that as the starting position is reached, roller 12 seats in the next dwell 44 and fold-forming bar 7 moves to the spaced position shown in dot-and-dash lines in Fig. 6 to release the folded sheet. The folded sheet is then discharged from between bars 6 and 7 and has an appearance in end elevation similar to that shown in Fig. 12.

This method of folding plastic sheet material secures an efficient and economical folding operation in which folding blade 34 is moved rather rapidly into engagement with a sheet to bend it between bars 6 and 7 in spaced relation. Then, with a rapidly decelerating motion of folding blade 34, the heat softens the plastic sheet material so that the sheet may be readily folded due to subsequent cooperation of fold-forming bars 6 and 7 with blade 34 in the manner above described. The decelerated or slow movement of folding blade 34 during the forming of the fold in the sheet is timed to give the heat sufficient opportunity to soften the material of the sheet throughout the fold portion to permanently form the material of the sheet into the folded position.

The invention claimed is:

1. The method of folding plastic sheet material consisting in supporting a sheet on a pair of spaced parallel heat absorbing ledges over a folding chamber with the portion to be folded located midway between said ledges, moving a heated folding blade laterally to the plane of said ledges and sheet to engage said sheet portion to be folded to start the heating of said sheet portion and slowly moving said sheet portion while continuing the heating thereof to soften the material in said sheet portion sufficiently to bend around said heated blade edge into said folding chamber into a folded position about said blade while sup-

ported by said ledges, retracting said folding blade from said folded sheet as soon as heated portions of said sheet engage said ledges while said ledges cooperate to support said folded sheet and rapidly absorb the heat from said sheet to permanently set the fold in said sheet portion, and then removing the sheet from said ledges and chamber.

2. The method of folding plastic sheet material consisting in supporting a sheet on a pair of spaced parallel fold-forming bars, moving a heated folding blade to engage said sheet midway between said bars to start heating of a narrow strip portion of said sheet and slowly moving the portion engaged by said blade while continuing heating of said strip portion with the blade between said bars to form a fold in said sheet about said blade while supported by said bars as rapidly as the heat softens the material in said strip portion sufficiently to bend about said blade, moving said bars toward said blade to additionally fold said sheet about the blade and grip said folded sheet while said blade continues heating said strip portion and said bars begin absorbing the heat from said sheet, withdrawing said blade from the fold in said sheet and from between said bars, moving said bars still closer together during the withdrawing of said blade to hold and further fold said sheet and for rapidly absorbing the heat in said sheet and cooling said folded sheet to cause said strip portion to permanently set in folded shape after withdrawal of said blade, and finally moving said bars apart and removing the completed folded sheet therefrom.

3. The method of folding plastic sheet material consisting in supporting a sheet on a pair of spaced parallel heat absorbing fold-forming bars, providing sheet gripping means in association with said bars, moving a heated folding blade to engage and start heating a strip portion of said sheet between said bars and slowly moving the central portion of said sheet therewith between said bars while continuing the heating of said strip portion to soften the material sufficiently to bend said sheet about said blade therebetween, maintaining said blade in sheet-folding position for a limited time between said bars sufficient to heat the material in said sheet to form a permanent fold therein about said blade, moving said bars and sheet gripping means toward one another at opposite sides of said folded sheet to additionally fold said sheet about said blade and to grip and hold said sheet in said gripping means, withdrawing said blade from the fold in said sheet and from between said bars, moving said bars still closer together to more fully engage said bars to tightly fold said sheet and rapidly absorb the heat in said sheet to cool the sheet for permanently setting the fold, and subsequently moving said bars apart into the original spaced parallel relation to release said gripping means and bars from said sheet and removing said folded sheet therefrom.

4. The method of folding plastic sheet material consisting in supporting a sheet along spaced parallel portions thereof moving a heated folding blade to engage a narrow edge thereof with a narrow strip portion at the central portion of said sheet between said spaced parallel supported portions for cooperation therewith to fold said sheet at said narrow strip portion, maintaining said blade with only said narrow edge engaged with said narrow strip portion a limited time sufficient to heat said strip portion to soften the material in said strip portion sufficiently to bend,

slowly moving said blade while continuing heating of said strip portion to form it into a fold at the edge of said blade while continuing to support said sheet at said spaced parallel portions, withdrawing said blade from said folded sheet after said blade has completely folded said sheet and more fully engaged said folded sheet between said supporting portions without engaging said sheet during withdrawal while said sheet remains supported at said spaced parallel portions for rapid absorption of heat thereby cooling of the fold formed in said narrow strip portion while maintained in spaced relation to said blade, and finally removing said folded sheet after cooling of said fold portion from support along said spaced parallel portions.

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