May 10, 1955 H. PETZAL ET AL 2,708,059

PLEATING OPERATIONS

Filed June 17, 1953 4 Sheets-Sheet 1

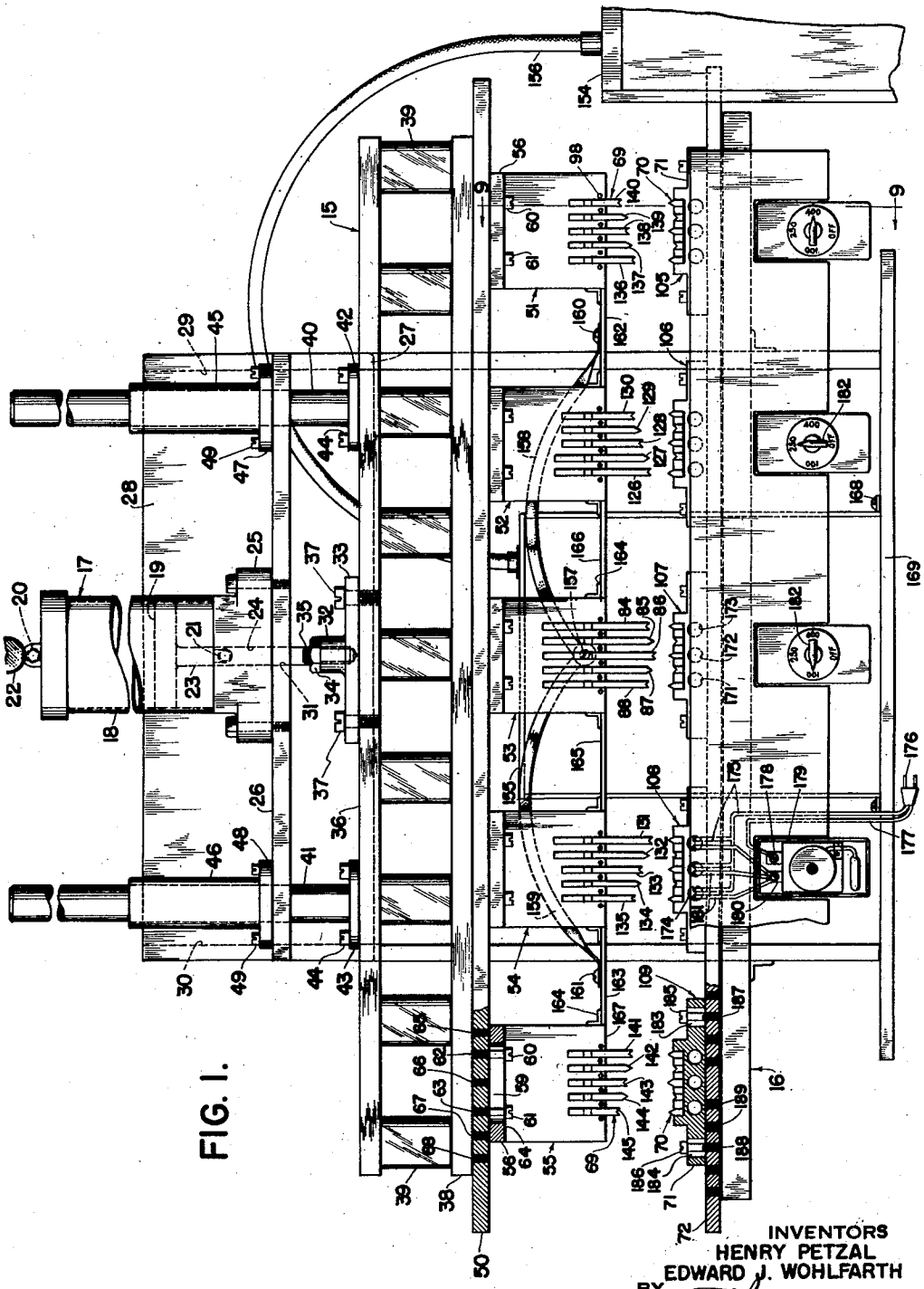


FIG. 1.

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4 Sheets-Sheet 2

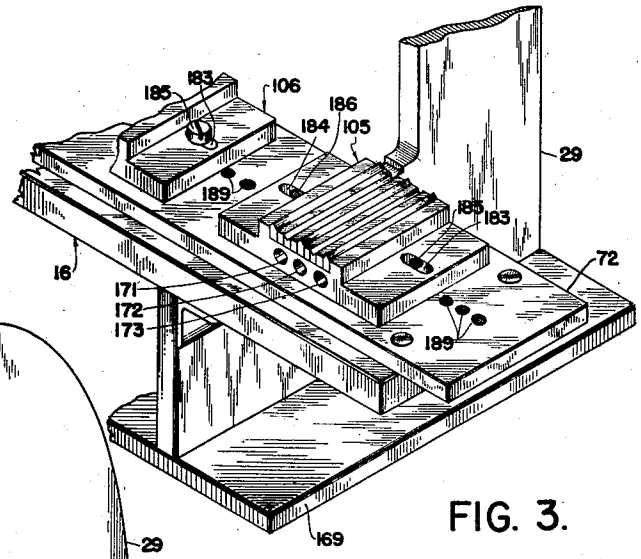


FIG. 3.

FIG. 2.

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PLEATING OPERATIONS

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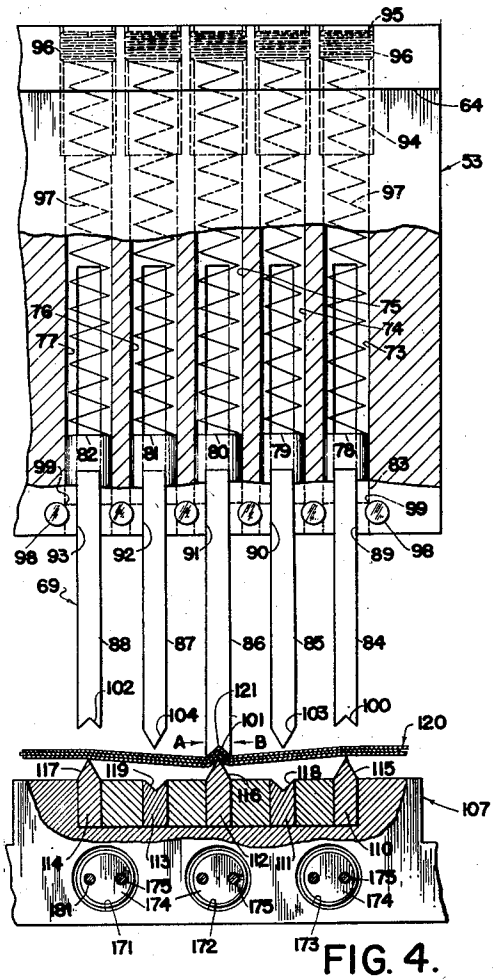


FIG. 4.

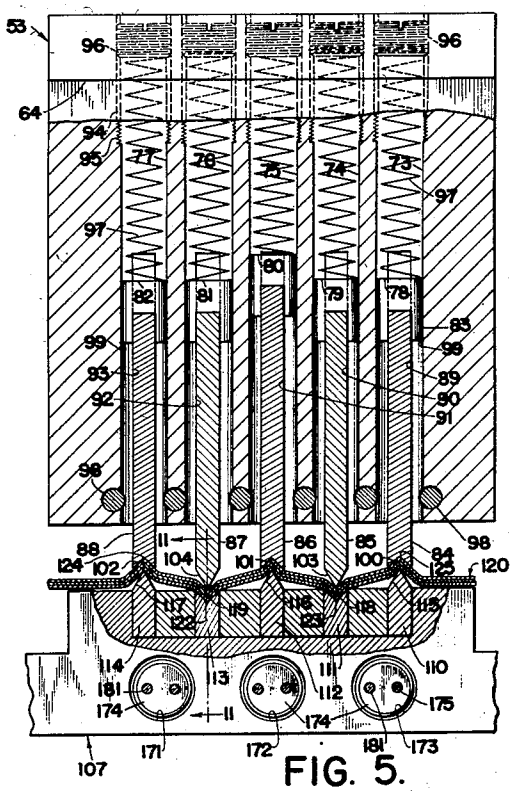


FIG. 5.

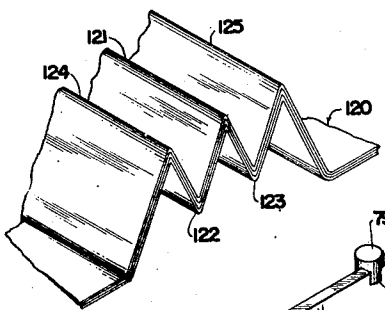


FIG. 7.

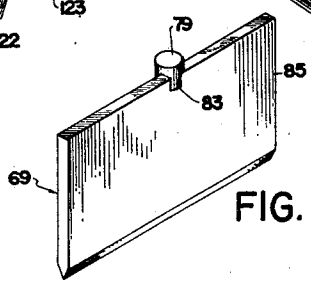


FIG. 6.

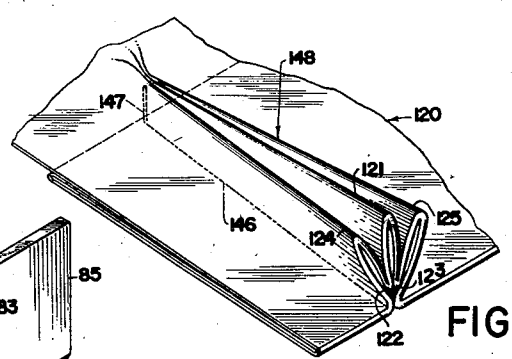


FIG. 8.

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PLEATING OPERATIONS

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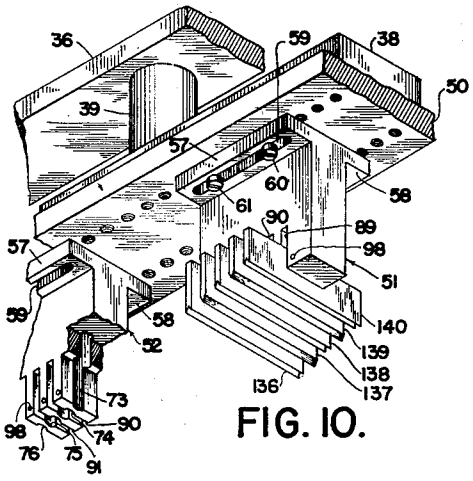


FIG. 10.

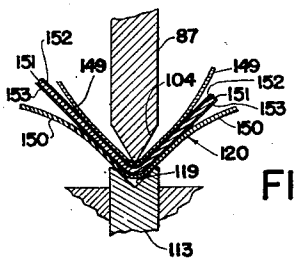


FIG. 11.

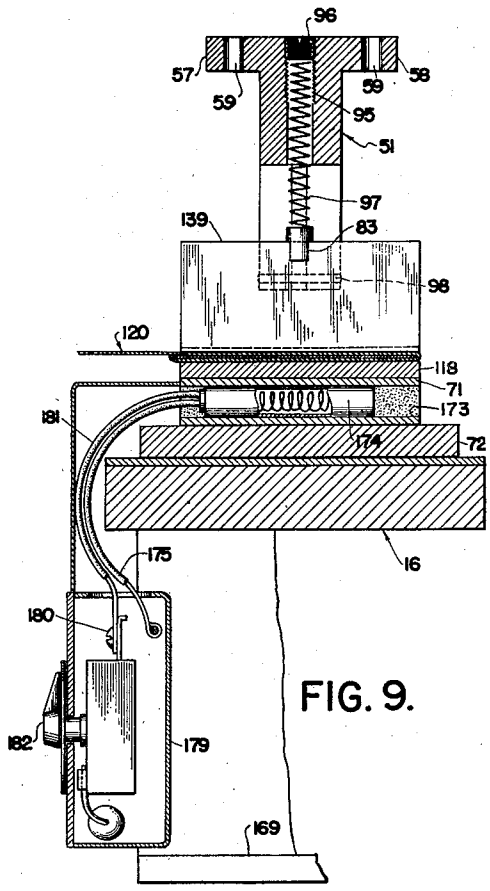


FIG. 9.

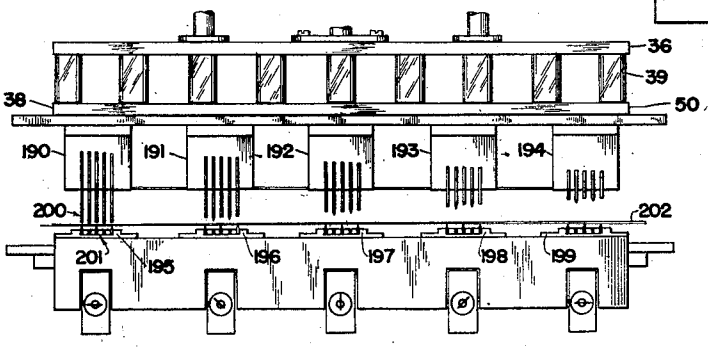


FIG. 12.

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2,708,059

PLEATING OPERATIONS

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Application June 17, 1953, Serial No. 362,356

11 Claims. (Cl. 223—30)

This invention relates to crease-forming machines for making fold lines preparatory to pleating operations, and has particular applicability to textiles and other fabrics which are to be fabricated into pleated form, such as fabrics for curtains with pleated headings.

According to known conventional methods, pleats are formed manually, and where mass production techniques are used, a number of operators are employed to perform different predetermined operations. It is the common practice, for example, to include, among such operations, the steps of estimating the width of the section to be pleated, measuring such width, manually forming in the selected section the required number of fold lines, folding said section along said fold lines into pleats, and completing the operation by sewing together the pleated portions upon conventional sewing machines. In the fabrication of pleated curtains and draperies, a buckram lining is generally inserted within the heading to give body thereto and also to facilitate the pleating operation.

It is within the contemplation of our invention to eliminate certain of the manual operations generally used in pleating procedures, it being our specific object mechanically to form folded lines which define the various pleats, whereby the subsequent operations of manually creating the folds and sewing them can be readily accomplished.

It is the further object of our invention to apply our novel crease-forming apparatus upon fabric provided with buckram lining, particularly in curtains and draperies, whereby the buckram will be held against shifting relative to the adjacent fabric.

In this aspect of our invention buckram suitably coated with plastic material, such as vinyl, is employed, our apparatus being adapted to induce within the material sufficient heat to cause a softening of the coating and a consequent adhesion of the buckram to adjacent sections of the fabric, the said heating operation occurring as part of the crease-forming process. It is this adhesion that prevents any shifting between the lining and the outer material during the crease-forming operation.

It is also within our contemplation to enable our apparatus to perform its said crease-forming operations with or without the use of heat; and where heat is necessary, our apparatus is adapted to generate heat either by conduction or by the creation of a dielectric field, or by both such methods simultaneously.

It is also an object of our invention to render the device adjustable for varying the distance between the formed fold lines, and thus to create pleats of various proportions and spacing, depending upon the particular requirements or the characteristics of the fabric. In the accomplishment of this aspect of our invention we employ a plurality of crease-forming units each having a male die member comprising a plurality of crease-forming punches or bars, these being removable and adjustable to meet particular requirements. And in the further accomplishment of this objective, our novel apparatus contains a base section adapted to underlie the material and comprising a plurality of die members corresponding in position and proportions to the said punches and bars.

It is also our object to apply heat both to the male and female crease-forming dies, whereby such heat, when it is required, will be effective in performing the objectives hereinabove mentioned and during the operative coaction between the said male and female die members. The said die members are so formed that when one is brought into co-active relation with the other, the material is pressed therebetween, and fold lines accordingly formed, such lines extending through opposite faces of the fabric, and where buckram is employed as a lining, through said buckram also.

It is also an important object of our invention to take into account the necessary contraction of the fabric being worked on during the crease-forming process. In other words, when the fabric is deformed by the production of said creases therein, portions thereof are alternately depressed and raised, so as to create the zig-zag formations characteristic of pleated material. There are thus sections which extend outside of the plane of the fabric, that is, above and below the plane. It is obvious that any process for depressing and raising the material, in a crease-forming operation, would cause a drawing-in and a corresponding reduction in the dimensions of the creased fabric. If no provision is made to take such shrinkage into account, the application of simultaneous pressure along the entire extent of the fabric being treated would, under known conventional methods, cause either an undesired stretching thereof, or a rupture. It is accordingly within our contemplation to obviate this danger by enabling the required shrinkage to occur without inducing any undesirable stresses within the fabric. This objective is accomplished by progressively applying crease-forming pressure along the extent of the fabric, so as to permit each section as it is being acted upon to adjust itself to the pressure without causing a pull on other portions. In one form of our invention the operative pressure is first applied at the central portion of the fabric and then progressively outwardly therefrom; and in another form the pressure starts at one end of the fabric and progressively continues towards the other end. The arrangement is hence such that there is no crease-forming engagement of the male and female dies simultaneously throughout the extent of the piece being treated, each section, as aforesaid, being afforded the opportunity independently to contract under the influence of the crease-forming operations being performed thereupon.

It is also within our contemplation, in one aspect of our invention, to take into account the different periods of contact of the various die members with the material being treated, for in certain cases it is important that there be correspondingly adjusted temperature variations depending upon the dwell of the heating dies against the material. More specifically, in the above-mentioned case of progressive action, the dies that engage the material first are maintained in engagement therewith for a longer period than the dies that come into engagement successively thereafter; and to meet this situation, means are provided in our invention for applying more intense heat to the dies whose dwell upon the material is of shorter duration, thereby providing compensating heating means for all the dies in inverse ratio to their respective periods of contact with the material being treated.

It is also within our contemplation to provide yieldable means, in association with each of the crease-forming dies, where the above-mentioned progressive contact system is employed, so that as certain of the dies come into engagement with the material, the previously engaging dies will be yieldably maintained in position.

And it is within our contemplation to provide a sim-

ple and readily operated apparatus which will produce the said fold lines for pleating, so as to enable an operator readily to form pleated sections ready for a conventional sewing operation to complete the work.

Referring to the drawings,

Figure 1 is a front fragmentary elevational view of an apparatus according to our invention, portions being removed and sectioned for clarity, the device being shown in its retracted position.

Figure 2 is a fragmentary side view of Figure 1, a sheet of material to be pleated being shown operatively in place.

Figure 3 is a fragmentary perspective of the lower right-hand portion of the apparatus of Figure 1, showing the bedplate and dies at one end of the structure, portions being removed for clarity.

Figure 4 is an enlarged fragmentary front view of the central portion of the apparatus of Figure 1, a portion of the sheet material for processing being shown operatively in place, the punch and die members being shown at the initial portion of contact with said material, fragments of the apparatus being removed and sectioned for clarity.

Figure 5 is a view of the portion of the apparatus illustrated in Figure 4, shown partly in section, the punch and die members being all shown in full engagement with said sheet operatively therebetween, the section being taken substantially along line 5—5 of Figure 2.

Figure 6 is a perspective view of one of the punch members employed in the said apparatus.

Figure 7 is a fragmentary perspective view of a fragment of the processed sheet of Figure 5, shown with fold lines formed therein by the apparatus preparatory to a subsequent pleating operation.

Figure 8 is a fragmentary perspective of a portion of the sheet of Figure 7 after the pleating operation has been completed.

Figure 9 is an enlarged fragmentary section of Figure 1 taken substantially along line 9—9, portions being removed for clarity, the sheet for processing being shown in place as indicated in Figure 2.

Figure 10 is a bottom fragmentary perspective of the upper right-hand side of the apparatus of Figure 1, fragments being removed for clarity.

Figure 11 is a fragmentary enlarged vertical section of a punch and die member operatively engaging therebetween a section of material being processed, the section being taken substantially along line 11—11 of Figure 5.

Figure 12 is a fragmentary front elevational view of a modified form of apparatus shown in operative engagement with sheet material operatively in place for processing.

In the form of our invention illustrated in Figures 1 to 10, a press apparatus is employed having a ram member 15 and a bedplate 16, the former carrying punch members and the latter coacting die members, the said ram being operatively movable between upper and lower limiting positions by suitable actuating means. The specific embodiment shown illustrates such actuating means as a pneumatic device 17 comprising a cylinder 18, a piston 19, inlet and outlet fittings 20 and 21 and a pressure gauge 22. Extending downwardly from piston 19 is the piston rod 23 which is slidably movable through the aperture 24 in base 25 of actuator 17, the latter resting upon the horizontal shelf 26 of the angle bar 27 secured to the front plate 28 connecting the two laterally opposite vertical walls 29 and 30 (Figures 1 and 2). The said piston rod 23 extends through the aperture 31 of said shelf 26 and is in threaded engagement with the centrally recessed boss 32 integral with the flange 33, nut 34 being mounted over and in threaded engagement with the lower threaded portion 35 of piston rod 23, said nut being in engagement with the top of said boss 32. The said flange 33 is secured

to the upper plate 36 of ram 15 by the fasteners 37, the lower plate 38 of said ram being spaced from plate 36 and separated therefrom by a plurality of insulators 39. Mounted on said upper plate 36 are the laterally opposite posts 40 and 41, the respective bases 42 and 43 thereof being secured by fasteners 44 to said upper plate 36. Said posts 40 and 41 extend upwardly through and are in slidable engagement with the inner walls of the respective centrally apertured guide cylinders 45 and 46, the respective bases 47 and 48 of which are secured by fasteners 49 to the said shelf 26.

The arrangement is hence such that upon an operative vertical movement of said piston 19, in known manner, the said ram 15 will be correspondingly moved between its upper and lower limiting positions, the said posts 40 and 41 cooperating with the guide cylinders 45 and 46 to maintain the ram in its vertical path and hold it against lateral displacement.

Attached to the undersurface of said lower plate 38 of ram 15 is the punch plate 50; and adjustably secured to said punch plate are the horizontally aligned punch holders 51, 52, 53, 54 and 55. Each of said punch holders has a flanged base 56 comprising front and rear extensions 57 and 58, respectively (see Figures 2 and 10). Said front and rear extensions each contains an elongated slotted portion 59 through which extend the shanks of two bolts 60 and 61, the heads of said bolts extending beyond the opposite longitudinal walls defining said slots, the threaded shanks extending into and being in threaded engagement with correspondingly positioned threaded apertures, such as 62 and 63, in said punch plate 50, the heads of said bolts 60 and 61 being in engagement with the undersurface 64 of said extensions 57 and 58, thereby maintaining the respective punch holders secured to the punch plate 50. On opposite sides of said threaded apertured portions 62 and 63 are other apertured portions 65, 66, 67, and 68, each proportioned and positioned to receive therein the shanks of said bolts 60 and 61.

The arrangement is hence such that said bolts 60 and 61 can be detected from the respective apertured portions with which they are in engagement, such as apertured portions 62 and 63, and shifted to positions where they can be brought into threaded engagement with two of said other apertured portions 65, 66, 67 and 68, thereby to enable the said punch holders 51, 52, 53, 54 and 55 to be shifted laterally relative to each other and secured in such shifted positions to the punch plate 50, in accordance with the requirements of the particular operation, as will more clearly hereinafter appear.

Each of said punch holders contains therein a plurality of punches, generally designated 69, which are adapted to coact with correspondingly positioned and proportioned dies, generally designated 70, disposed in the die holders generally designated 71 adjustably mounted on the die plate 72. The said punches 69 are supported by and vertically movable relative to said punch holders, and are urged downwardly by spring means to a lower limiting position, the arrangement being such that when a sheet of material is operatively placed for processing between said punches and dies, and the ram 15 operatively moved downwardly, correspondingly positioned punches and dies will engage said material and form therebetween fold lines in predetermined spaced relation, in a manner to be more specifically hereinafter described.

The said punch construction is clearly illustrated in Figures 4, 5, 6, 9 and 10. Punch holder 53 contains a plurality of vertical parallel cylindrical cavities or bores 73, 74, 75, 76 and 77 each proportioned to slidably accommodate the respective plungers 78, 79, 80, 81 and 82, said plungers having bifurcated lower portions 83 (Figure 6) straddling and fixedly secured to the upper central portions of the respective punches. As specifically illustrated in Figures 4 and 5, the said plungers 78 to 82 are mounted upon the respective punches 84, 85, 86,

87 and 88. Said punches, of a predetermined width to correspond with the desired width of the fold lines or creases, slidably extend through the slots 89, 90, 91, 92 and 93 of the respective punch holders. The said bores 73 to 77 extend vertically downwardly from upper to the lower portions of the respective punch holders, the upper portions of each of said bores containing enlarged portions 94 with threaded walls 95 containing therein the adjusting top screws 96, each of said screws being in threaded engagement with said threaded wall portions 95. Disposed between each of said adjusting screws 96 and the respective plungers 78 to 82 are helical springs 97 urging the respective plungers and their corresponding punches downwardly towards the lowermost position defined by the stop rods 98 extending horizontally through the lower portions of said punch holders. Each of said punches is flanked by two of said rods, the said rods being so positioned as to extend slightly into the respective bores 73 to 77, inclusive, whereby they are positioned in intercepting relation to the path of said plungers 78 to 82, respectively. Hence, under the urging of said springs 97, said plungers 78 to 82 can move downwardly only until their lowermost corners 99 engage the rods 98. The arrangement is thus such that rods 98 serve as bottom stops to limit the downward movement of the punches 84 to 88, inclusive. The tension of each of said springs 97 can be regulated by a manipulative turning of the screws 96.

It will be observed that the bottom forming terminals of certain of said punches are upwardly recessed whereas others are downwardly pointed. For example, punches 84, 86 and 88 contain recessed V-shaped forming terminals 100, 101 and 102, respectively, whereas the punches 85 and 87 contain downwardly pointing V-shaped forming terminals 103 and 104, respectively.

As aforesaid, there are die holders 71 corresponding in position to the said punch holders. In the specific apparatus illustrated, die holder 105 coacts with punch holder 51, die holder 106 coacts with punch holder 52, die holder 107 coacts with punch holder 53, die holder 108 coacts with punch holder 54 and die holder 109 coacts with punch holder 55. By referring to Figures 4 and 5 it will be seen that die holder 107 contains therein the dies 110, 111, 112, 113 and 114 corresponding in position and in coactive configuration to the said punches 84, 85, 86, 87 and 88, respectively. Dies 110, 112 and 114 have their respective upper forming terminals 115, 116 and 117 shaped as upwardly extending V-portions, proportioned and shaped to coact with the upwardly recessed portions 100, 101, and 102 of the corresponding punches 84, 86 and 88; and the dies 111 and 113 have their forming terminals 118 and 119 recessed downwardly to serve as complementary coacting members for the forming terminals 103 and 104 of the punch members 85 and 87, respectively. The arrangement is hence such that the punches and dies have alternate recessed and protruding forming terminals, so as to produce a conventional zig-zag crease formation in the material, as will more clearly hereinafter appear.

As will be seen from Figures 4 and 5, sheet material generally designated 120 is positioned between the said punches and dies. Upon the operative downward movement of the punch holder 53, punch 86 first comes into contact with the upper surface of sheet 120, bringing the undersurface thereof into engagement with die 112. A continued downward pressure causes the formation of the fold 121 extending upwardly from the plane of the material. A continued downward movement of punch holder 53 causes the punches 85 and 87 to engage the sheet 120, whereafter the punches 84 and 88 engage it—thereby progressively forming the downwardly extending folds 122 and 123 and the upwardly extending folds 124 and 125. It will be noted, from Figure 5, that when the punches are in their operative crease-forming positions, the plungers 78, 79, 80, 81 and 82 are disposed about mid-way up within their respective bores, leaving spaces between said plungers and the respective screws 96 to permit a further upward movement of the punches as the ram 15 continues downwardly to bring the other punches into operative engagement with the material. During the said continued downward movement of ram 15, the punches in punch holders 52 and 53 next progressively come into engagement with the material, whereafter the punches in the end punch holders 51 and 55 come into progressive engagement with the material.

This progressive operation is effectuated because of the fact that in their retracted or non-contacting positions, the punches flanking those of punch holder 53 have their bottom forming terminals at progressively higher positions above their corresponding dies. Thus, in punch holder 52, the forming terminals of the successive punches, 126, 127, 128, 129 and 130 are arranged in progressively higher positions above the correspondingly positioned dies of die holder 106. Similarly in punch holder 54, the terminals of successive punches 131, 132, 133, 134 and 135 are arranged in progressively higher positions relative to the corresponding dies of die holder 108. And at the opposite ends of the apparatus, the terminals of the successive punches 136, 137, 138, 139 and 140 are arranged in progressively higher positions relative to the corresponding dies of die holder 105; and the terminals of successive punches 141, 142, 143, 144 and 145 are arranged in progressively higher positions above the corresponding dies of die holder 109. It is preferred that the operative terminals of the next adjacent punches of adjacent punch holders be at the same level. For example, in the form illustrated in Figure 1, the forming terminals of punches 84 and 88 are, respectively, at substantially the same levels as the forming terminals of punches 126 and 131; and the forming terminals of punches 130 and 135 are at substantially the same level as the forming terminals of punches 136 and 141, respectively.

The arrangement is hence such that when the punches of punch holder 53 complete their operative engagement with sheet material 120, the punches of the laterally adjacent punch holders 52 and 54 begin their operative engagement with the material; and when said latter punches complete their respective engagements with the material, the punches of punch holders 51 and 55 begin their operative engagement therewith.

Because of the progressive engagement of punches with the material as above-described, those internal stresses which might be induced within the material if all the punches simultaneously engaged the material are eliminated. For example, when the material is engaged by punch 86 and die 112 (Figure 4), the material in the region of fold 121 is forced upwardly above the plane of the material, causing a slight drawing in of the material in the direction of arrows A and B. This said drawing-in action is rendered possible because of the fact that none of the adjacent punches are in engagement with the material to interfere therewith. This progressive action continues, permitting each fold to be formed without inducing any undue strains or pulls within the adjacent portions of the material.

It will be further noted that in no case do the plungers mounted on top of the dies, such as plungers 78 to 82, reach the tops of the bores or strike the screws 96. The crease-forming operation is thus a yieldable one, the said springs 97 providing sufficient force to the punches to produce the required crease-forming operations. It has also been found that this yieldable engagement of the punches with the material reduces the danger of a rupture or damage to the material, and permits a slight shifting thereof in the event of a pull that may be inadvertently induced within the material.

Figure 7 shows a portion of the sheet material in its operatively creased or folded condition, the section illustrated being that illustrated in Figure 5—folds 124 and

122, for example, having been formed by the punch 88 and die 114, and by the punch 87 and die 113, respectively. Figure 8 shows how the three illustrated sections are thereafter gathered and sewed together by stitching 146 and 147 to form the pleated section 148.

Figure 11 shows the sheet material 120 in section, the fold being formed therein by the punch 87 and die 113. It will be seen that the material consists, in the embodiment illustrated, of an upper layer 149, a bottom layer 150, and a sheet of lining material 151 which may be made of buckram, and which has upper and lower coatings 152 and 153 of a material that will soften under heat, such as vinyl. When the said sheet 120 is subjected to heat by one or more of the methods to be hereinafter described, the heat sensitive coatings 152 and 153 will soften and become adhesively secured to the upper and lower layers 149 and 150. This will prevent a shifting of the lining 151 with respect to the said upper and lower layers 149 and 150, and thereby enable well defined folds to be formed.

The particular embodiment illustrated shows two different heating methods for supplying heat to the punches and dies, whenever that may be necessary. One of such methods produces a dielectric field between the punches and dies, the material for processing being disposed within the field and being heated thereby. The other method employs, below the dies, an arrangement of heating coils to heat the dies and the material thereupon. The said heating methods may either separately or simultaneously be employed, depending upon the nature and construction of the sheet material being treated. For example, when the fabric contains metal threads therein, the dielectric field method is not employed, since the metal threads would short-circuit the field and interfere with its efficacy, and in such a case only the lower coil heating system is employed.

When it is desired to produce different heating intensities in different sections of the material being treated, the said lower heating coil system may be effectively utilized. This is frequently necessary to compensate for the differences in contacting periods between different sets of punches and dies. For example, because the punches of punch holder 53 are the first to come into engagement with the material, they remain in engagement therewith until all the other sets of punches have been brought into operative contact with the material. On the other hand, the punches of punch holders 51 and 55 are the last to come into engagement with the material being treated, and their dwell upon the material is consequently the shortest. It thus may become necessary to supply the punches and their holders 51 and 55 with a greater amount or greater intensity of heat than may be necessary for the others, the punches of holder 53 being provided with less intense heat then is required for the other punches and their respective holders 52, 53, 51 and 55.

The dielectric field, in the particular embodiment shown, is produced by the conventional high-frequency generator 154 which is connected to the conventional tuner 155 by the coaxial cable 156. The details of said generator and tuner need not be described herein, since they are well known to those skilled in the art, and a description thereof is not necessary for an understanding of the present invention. Suffice to say, for present purposes, that from terminal 157 of tuner 155 are two flexible conductors 158 and 159, secured by the respective fasteners 160 and 161 to brass plates 162 and 163, respectively. The said brass plates are attached by angles 164 to the adjacent punch holders. There are other similar brass plates 165 and 166 which are similarly attached to the adjacent punch holders. It is preferred that the undersides of said brass plates be at the same level as the undersides 167 of said punch holders, thereby to form a continuous undersurface extending from the bottom of punch holder 51 to the bottom of punch holder 55. The said tuning box is grounded at terminals 168 to the metal base plate 169 which rests upon the table 170 (Figures 1 and 2). When the generator 154 and tuner 155 are in operation, a dielectric field is set up between the punch holders and said brass plates 163 on the one hand, and the metal die plate 72 extending therebelow on the other. It is within this dielectric field that the sheet material for processing is placed, as aforesaid, said sheet being thus subjected to the effects of the heat generated thereby for facilitating the crease-forming operation, depending upon the nature of the material.

Each die holder, in the embodiment illustrated, contains in the base thereof three cavities 171, 172 and 173. In each of these a cartridge 174 is placed, said cartridge containing a conventional heating coil. Said three cartridges are connected in parallel, by conductors 175 (Figures 1 and 9), to the wall plug 176, the conductor 177 from said plug leading to the terminal 178 of control box 179. The opposite terminal 180 of said control box is operatively connected, by conductors 181, to the said cartridges 174. The said control box is provided with a hand manipulative dial structure 182 which controls a conventional make-and-break mechanism for controlling the heat generated by said cartridges, within a given unit of time. This is a conventional structure well known to those skilled in the art; and a description thereof is hence not deemed necessary for an understanding of the present invention. The control boxes 179, through the operative selective manipulation of dials 182, can pre-set the amount of heat generated by said cartridges 174 in the various die holders 105, 106, 107, 108 and 109. Hence, the setting can be so adjusted that the dies of end holders 105 and 109 will receive a greater amount of heat per unit of time than the other holders, and said other holders can be similarly regulated as to temperature in inverse ratio to the dwell of the corresponding sets of punches upon the material.

It is thus apparent that when the ram 15 is in its upper retracted position, as illustrated in Figure 1, either a dielectric field can be set up, or the die holders may be heated by the cartridges 174, or both can be simultaneously set into operation. When the ram operatively moves downwardly to bring the punches and dies into operative engagement with the material being treated, the flexibility of cables 158 and 159 permits the dielectric field to be maintained during such movement. The pressure of the punches and dies upon the material, together with the heat generated within the material by either or both of the methods aforesaid, causes the material to be creased in accordance with the position and formations of the dies.

Should it be desired to change the spacing between the sets of punches and dies, adjusting means are provided therefor, as aforesaid. The punch holders can be shifted laterally by manipulating the bolts 60 and 61 in the manner above-described, so as to bring them into operative engagement with pairs of the various threaded holes 62, 63, 65, 66, 67 and 68 in punch plate 59. The die holders can similarly be shifted by virtue of the elongated slots 183 and 184 in the bases of the respective die holders. Extending through said slots are the bolts 185 and 186, respectively, the shanks of these bolts being adapted for threaded engagement with correspondingly positioned pairs of threaded holes 187 and 188 in the die plate 72 (see Figures 1 and 3). The said die plate is also provided with other holes 189 which are positioned to receive said bolts 185 and 186 when the respective die holders are in their shifted positions.

Figure 12 illustrates another arrangement of progressively positioned punches. The punch holders 190, 191, 192, 193 and 194 are coactively positioned with respect to the die holders 195, 196, 197, 198 and 199, respectively. The said punches, generally designated 200, have their lower extremities at progressively increasing distances from their coactively positioned dies, generally desig-

nated 201. After the first contact with the material 202 is made by the punches of holder 190, contact thereafter is progressively made by the punches of holders 191, 192, 193 and 194, the action being substantially the same as it is on either side of punch 86 in the form first above-described. As in the structure of Figure 1, the embodiment of Figure 12 enables a progressive crease-forming operation to be effected without the danger of rupture or undue strain within the material.

In the above description, the invention has been disclosed merely by way of example and in preferred manner; but obviously many variations and modifications may be made therein. It is to be understood, therefore, that the invention is not limited to any specific form or manner or practicing same, except insofar as such limitations are specified in the appended claims.

We claim:

1. In a crease-forming apparatus for making fold lines in a sheet of material preparatory to pleating operations, a ram movable between upper and lower limiting positions, a plurality of punch holders secured to said ram, a set of spaced punches on each of said holders, a stationary bedplate below said ram, a plurality of die holders secured to said bedplate and spaced to correspond with said punch holders, a set of dies on each of said die holders, each set comprising dies spaced to correspond with the punches on the corresponding punch holder and proportioned for operative coaction therewith, said corresponding punches and dies having respective forming terminals thereon shaped for mutual coaction, said coacting punches and dies being positioned relative to each other to accommodate therebetween said sheet in a predetermined working position in engagement with said dies, the punches being out of engagement with the sheet when the ram is in its said upper position and in pressing engagement therewith when in its said lower position, whereby the sheet is operatively engaged by both sets.

2. In a crease-forming apparatus, the combination according to claim 1, the distances between the forming terminals of successive pairs of coacting punches and dies of each pair of punch and die holders progressively increasing, successive pairs of punch and die holders having pairs of coacting punches and dies at greater distances apart than those of preceding pairs of coacting holders, and yieldable mounting for said punches.

3. In a crease-forming apparatus, the combination according to claim 1, said coacting punch and die holders comprising a central pair of said holders and on opposite lateral sides thereof at least one other pair of coacting holders, said central set having a central punch and coacting die and on opposite lateral sides thereof successive pairs of coacting punches and dies, the forming terminals of said successive pairs being progressively increasing distances apart, each of said other pairs of coacting holders having successive pairs of coacting punches and dies, the forming terminals of which are progressively increasing distances apart, the pairs of coacting punches and dies of said laterally positioned holders being generally farther apart than those of said central holders, and yieldable mountings for said punches.

4. In a crease-forming apparatus, the combination according to claim 1, said punch and die holders being laterally movable for adjustment, and releasable locking means in engagement with said holders.

5. In a crease-forming apparatus, the combination according to claim 1, a punch plate secured to said ram, a die plate secured to said bedplate, said punch and die holders being adjustably secured to said punch and die plates, respectively, and releasable locking means operatively connected to said punch holders and punch plates, and said die holders and die plates, whereby said punch holders may be adjustably shifted relative to each other, and said die holders may be correspondingly shifted relative to each other.

6. In a crease-forming apparatus for making fold lines in a sheet of material preparatory to pleating operations, a set of spaced punches having forming terminals thereon, a set of correspondingly spaced dies having forming terminals thereon shaped and positioned for operative coaction with said terminals of the punches, said sets being positioned relative to each other to accommodate therebetween said sheet in a predetermined working position in engagement with said dies, the distances between the forming terminals of a group of successive pairs of coacting punches and dies progressively increasing, means to move said punches between a retracted position in which they are out of engagement with said sheet and an operative position in which they are in pressing engagement therewith, whereby the sheet is operatively engaged by both sets, said punches being yieldably and progressively retractable upon their operative engagement with the sheet, a punch holder for said punches, said holder comprising a plurality of bores corresponding in number to said punches, plungers secured to said punches and slidably movable within said bores, and springs disposed within said bores and in engagement with said plungers, said springs being proportioned for compression when the punches are in operative engagement with said sheet.

7. In a crease-forming apparatus, the combination according to claim 6, and a plurality of stop rods extending through said holder and disposed between said plungers and said dies and extending into said bores, whereby they are in intercepting relation to the plungers and serve as stops for limiting the movement of said punches.

8. In a crease-forming apparatus, the combination according to claim 6, said bores having adjustable screw plugs therein, said springs being disposed between said plungers and said plugs.

9. In a crease-forming apparatus for making fold lines in a sheet of material preparatory to pleating operations, a set of spaced punches having forming terminals thereon, a set of correspondingly spaced dies having forming terminals thereon shaped and positioned for operative coaction with terminals of the punches, said sets being positioned relative to each other to accommodate therebetween said sheet in a predetermined working position in engagement with said dies, the distances between the forming terminals of a group of successive pairs of coacting punches and dies progressively increasing, means to move said punches between a retracted position in which they are out of engagement with said sheet and an operative position in which they are in pressing engagement therewith, whereby the sheet is operatively engaged by both sets, said punches being yieldably and progressively retractable upon their operative engagement with the sheet, a die holder for said dies, a plurality of cavities in said holder, and heating means within said cavities.

10. In a crease-forming apparatus for making fold lines in a sheet of material preparatory to pleating operations, a set of spaced punches having forming terminals thereon, a set of correspondingly spaced dies having forming terminals thereon shaped and positioned for operative coaction with said terminals of the punches, said sets being positioned relative to each other to accommodate therebetween said sheet in a predetermined working position in engagement with said dies, the distances between the forming terminals of a group of successive pairs of coacting punches and dies progressively increasing, means to move said punches between a retracted position in which they are out of engagement with said sheet and an operative position in which they are in pressing engagement therewith, whereby the sheet is operatively engaged by both sets, said punches being yieldably and progressively retractable upon their operative engagement with the sheet, a die holder for said dies, a plurality of cavities in said holder, electric heating coils within said cavities, and independent control means for each of said coils.

11. In a crease-forming apparatus, the combination according to claim 1, a conductor plate connecting said punch holders, a conductor plate connecting said die

holders, and high-frequency generating means electrically connected to both of said plates to produce therebetween a dielectric field.

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