Sept. 1, 1959 H. HOCHFELD 2,901,951

PROCESS AND MACHINE FOR PLEATING PLIABLE MATERIALS

Filed April 15, 1958 3 Sheets-Sheet 1

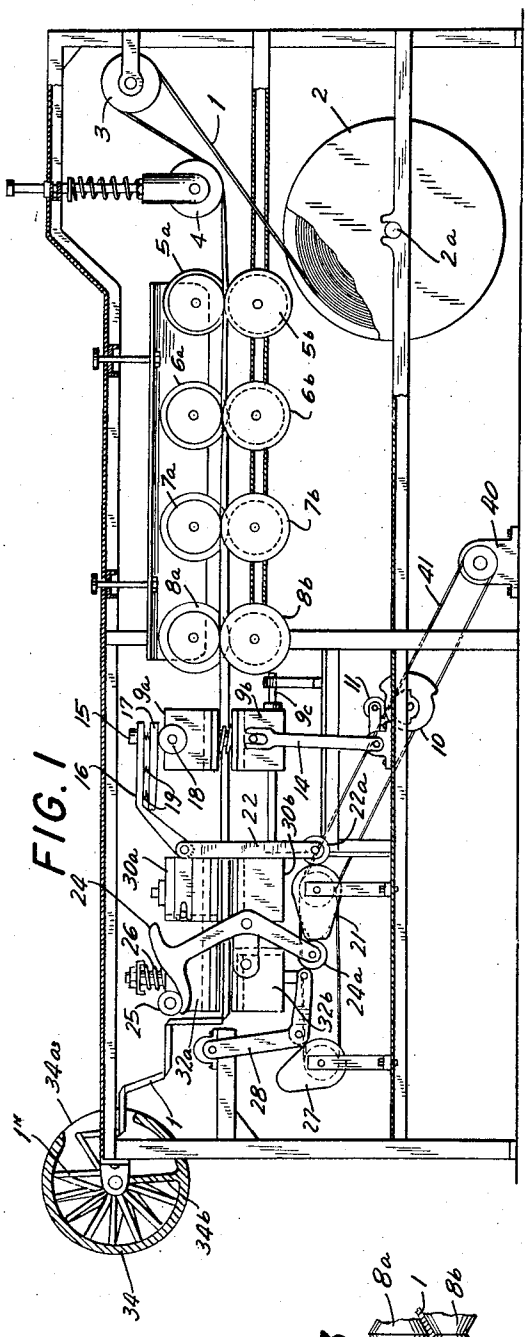

FIG. 1

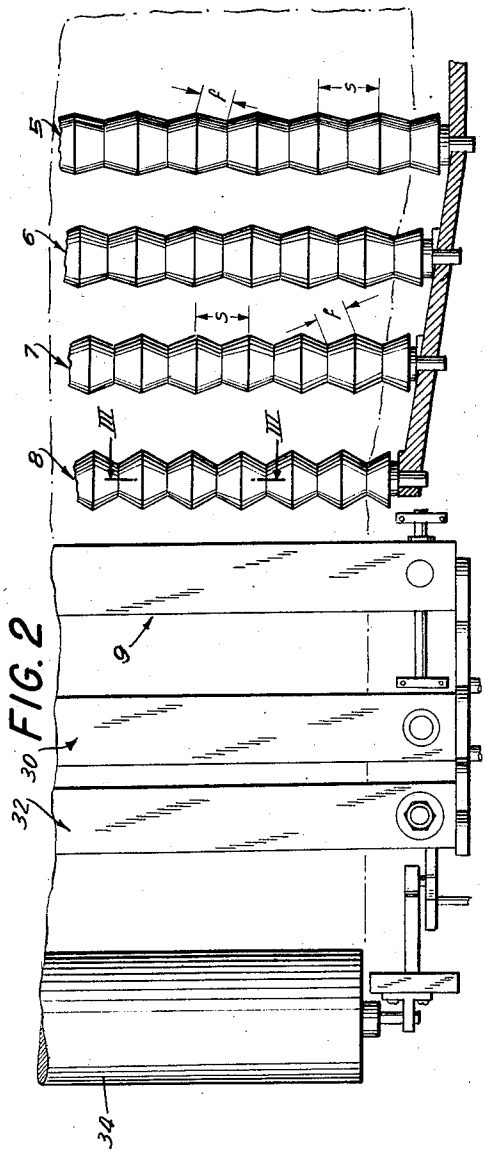

FIG. 2

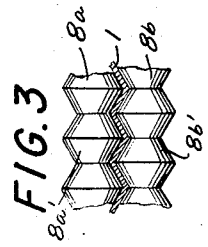

FIG. 3

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FIG. 4

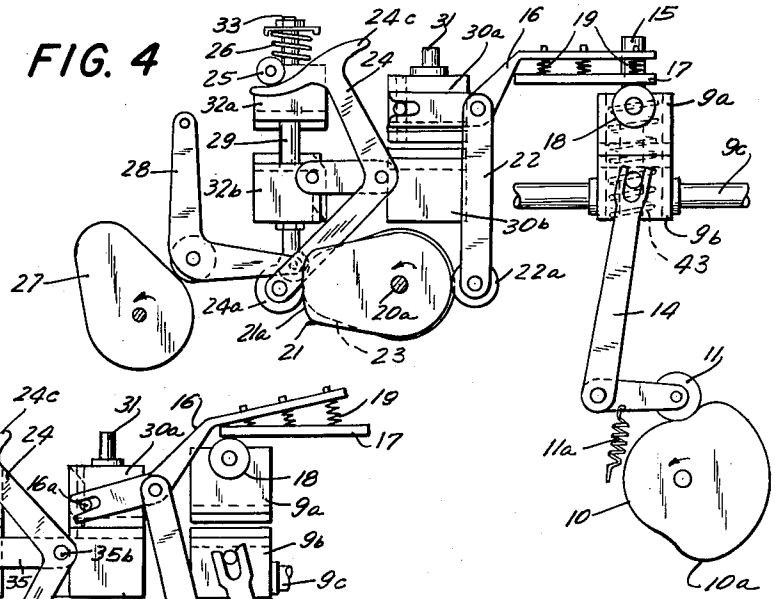


FIG. 5

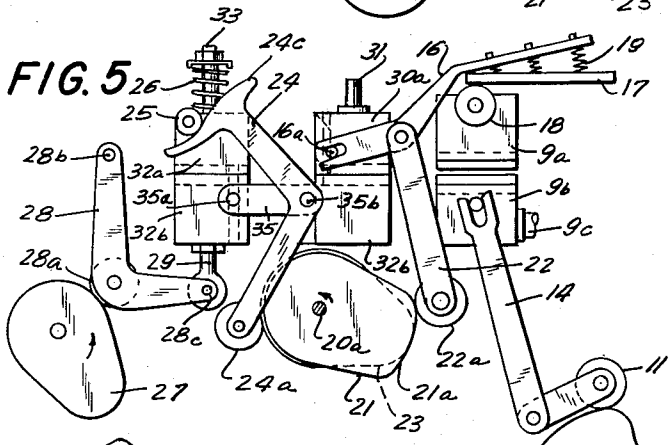


FIG. 6

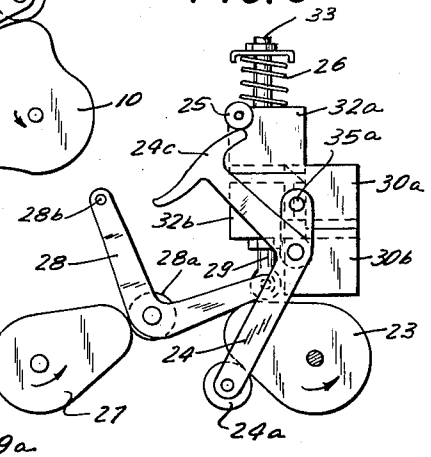
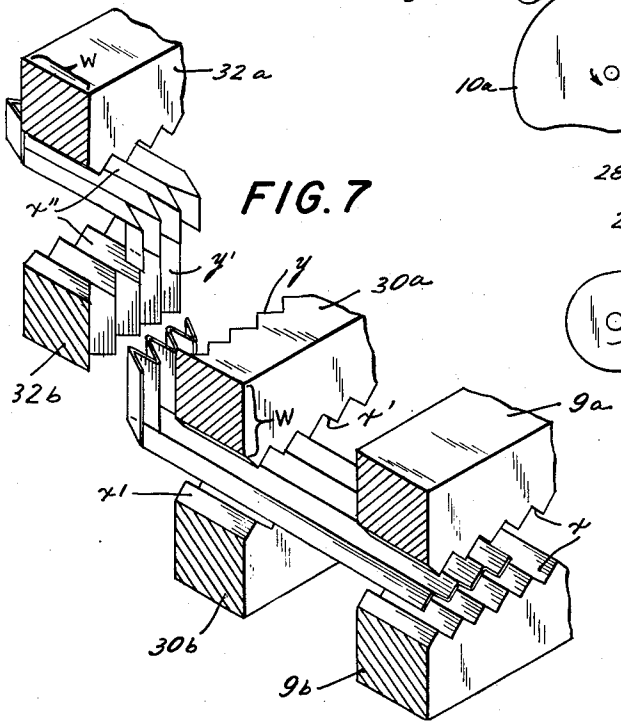


FIG. 7



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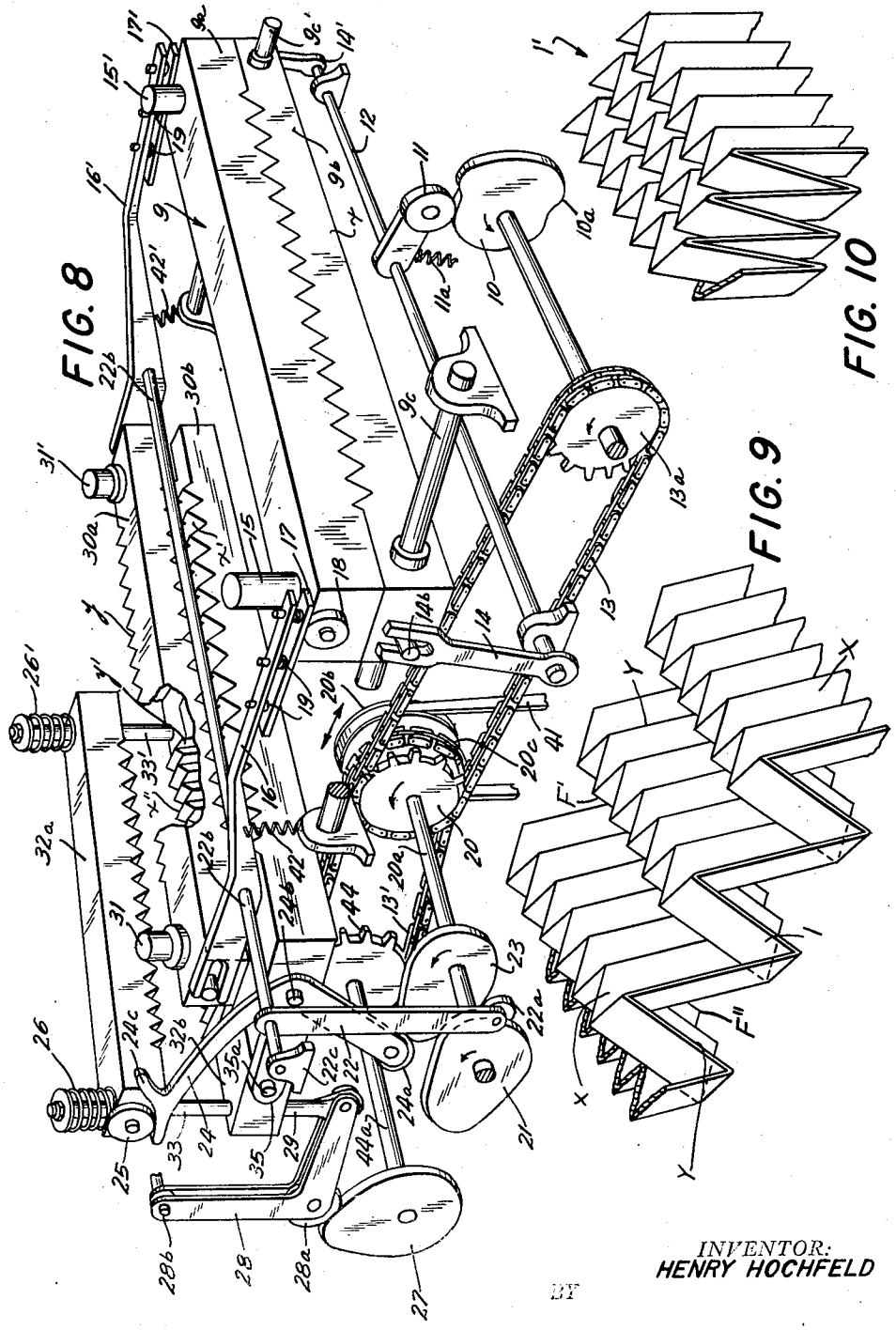

FIG. 8

FIG. 10

FIG. 9

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2,901,951

PROCESS AND MACHINE FOR PLEATING PLIABLE MATERIALS

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Application April 15, 1958, Serial No. 728,713

18 Claims. (Cl. 93—84)

My present invention relates to an automatic machine for pleating pliable materials and to an improved process for making complex pleated patterns in such materials.

The art of making complex pleated patterns in pliable materials such as paper, plastics, metal screen and foil, and textiles has utility in various industries for products, for example, in the garment industry for pleated fabrics for skirts and blouses, in the production of novelties and toys such as Chinese lanterns, and in filtration devices for the removal of particles from liquids and gases. These patterns are often quite difficult to make, for their execution requires a high order of skill when the folding is performed entirely by hand or with the aid of hand-operated jigs and fixtures, as is the case in current practice.

An object of this invention is to provide a machine for automatically producing direct and reverse folds in pliable materials.

Another object is to provide a pleating process which, whether executed automatically or by hand, will appreciably increase the production rate of so-called chevroned patterns in such materials.

A related object is the provision of an improved process and simplified means for the production of cylinders with hollow cores from pleated materials.

A feature of my invention resides in the provision of a process for pleating a sheet material in a series of steps including, first, a formation of a series of longitudinal corrugations in the sheet and, second, an intermittent reversal of these corrugations along transverse sections or zones of limited width. Advantageously, the width of the reversed sections equals the width of the non-reversed sections separating them whereby the finished pleat material can be converted by longitudinal pressure into a chevroned structure with the corrugations of adjacent sections interleaved.

According to another feature of my invention, the corrugations are formed in the sheet by a succession of pleating operations producing folds of progressively increasing depth whereby tears and breaks incidental to rapid crimping will be avoided.

According to a further feature of my invention I provide a machine having a preliminary folding section with a series of aligned dies, preferably in the form of rollers, which are successively traversed by the sheet material and produce therein the corrugations of gradually increasing depth. A main folding section comprises other dies, preferably in the form of split blocks forming pairs of serrated clamp jaws, which grasp sections of the pre-folded sheet and reverse the corrugations of other sections thereof. Advantageously, one of these dies is reciprocated to act as a means for advancing the sheet material, the stroke of reciprocation being preferably equal to the combined width of two sheet sections.

The invention will be further described with reference to the accompanying drawing, in which:

Fig. 1 is a side elevation of a machine embodying the invention;

Fig. 2 is a partial top plan view of the machine shown in Fig. 1;

Fig. 3 is a fragmentary cross-sectional view, taken along line III—III of Fig. 2;

Figs. 4, 5 and 6 are side views of a set of folding and reversing blocks forming part of the machine, at successive stages of the pleating cycle;

Fig. 7 is an exploded view in perspective showing part of the folding and reversing blocks together with the sheet material pleated thereby;

Fig. 8 is a perspective view of the movable blocks and their associated driving mechanism;

Fig. 9 is a perspective view of the pleated sheet material; and

Fig. 10 is a fragmentary perspective view of a chevroned structure produced from the material of Fig. 9.

In Fig. 1 a strip of sheet material **1** is show as being unwound from a supply roll **2** carried on a shaft **2***a*. This material travels around guide roller **3** and tension roller **4** to the preforming dies having the form of roller pairs **5**, **6**, **7** and **8**. Each of these pairs consists of an upper forming roller **5***a*, **6***a*, **7***a*, **8***a* and a lower forming roller **5***b*, **6***b*, **7***b*, **8***b*; the strip **1** passes between these rollers and receives preliminary impressions that lead up to the final required angle of fold.

The operation of the preliminary folding section of the machine including the preforming dies **5**—**8** will be clarified by reference to Fig. 3, which shows the strip **1** passing between rollers **8***a* and **8***b*. Each section **8***a*′, **8***b*′ of a particular roller is shaped in the form of a truncated double cone, with the truncations occurring close to the common base so that the complete roller has the configuration of a series of circular ridges and depressions. The upper and lower rollers are so positioned that the ridges fit into the depressions, and the material passing between them is longitudinally prefolded according to this pattern, i.e. the furrows and ridges of the fold extend parallel to the edges of the strip. It will be noted that, lest the sheet material be ruptured by a single deep-pleating operation, the initial set of preforming rollers **5***a*, **5***b* have relatively low ridges and shallow furrows, the angle subtended by the flanks of the conical sections of successive pairs becoming progressively more acute while their axial length is reduced from one roller pair to the next so that the depth of fold gradually increases, reaching its desired ultimate value at the last pair **8***a*, **8***b*. It will be noted that the length *f* of each flank is the same for all the rollers but that the spacing *s* between adjacent ridges (or troughs) of each roller progressively decreases from roller pair **5** to roller pair **8**.

The next step of the pleating process is performed by a feeding block **9** comprising upper and lower jaws **9***a* and **9***b*, each of which has a set of mating triangular serrations *x* on its inner surface, as shown in Figs. 7 and 8. These serrations substantially correspond in depth, width and flank inclination to the sections **8***a*′, **8***b*′ of the preforming rollers **8***a*, **8***b*. The number of serrations, of course, is equal to the number of preformed longitudinal folds and these serrations are positioned accurately aligned with the corresponding formations of the final preforming rollers. Vertical alignment of the jaws is achieved by posts **15** and **15**′, shown in Fig. 8. Each of these posts is surrounded by a compression spring (not shown) tending to separate the jaws from each other. The feeding block **9** is longitudinally reciprocable along horizontal guide rods **9***c*, **9***c*′ under the control of a driving mechanism shown to comprise a continuously moving chain **13**, a sprocket **13***a* engaged by the chain and driving a cam **10**, a cam follower **11** on a

shaft **12**, and a pair of levers **14**, **14'** on the extremities of this shaft, these levers having bifurcate ends straddling two pins **14***b* (only one shown) on the lower jaw **9***b*. Chain **13** is set in motion by a sprocket **20** whose shaft **20***a* carries a pulley **20***b*, the latter being driven by a motor **40** (Fig. 1) via a belt **41**.

The reverse-pleating operation is accomplished by the remaining blocks **30** and **32** which also consist of upper and lower jaws, in this case die members **30***a*, **30***b* and **32***a*, **32***b*, respectively. Each of these jaws is equipped with serrations *x'* and *x''*, which are coextensive with the serrations *x* of block **9**; but, in addition, upper jaw **30***a* and lower jaw **32***b* are equipped with reversing serrations *y* and *y'*, respectively, which are dimensionally equal to the other serrations but are in phase opposition thereto, i.e. they produce ridges where the latter produce furrows and vice versa. Lower jaw **30***b* is permanently positioned beyond the forward limit of the stroke of feeding block **9**, the length of this stroke being double the width *w* of the serrated face *y* of die member **30***a*; this width, in turn, equals that of the serrated faces *x''* of die members **32***a*, **32***b* (see Fig. 7). Jaws **30***a* and **30***b* constituting the supporting block **30** are maintained in vertical alignment by means of posts **31** and **31'**, so that member **30***a* can be lifted from its seat on member **30***b* along these posts. Similarly, jaws **32***a* and **32***b* which constitute the reversing block **32** (Fig. 2) are aligned by means of posts **33** and **33'**, which also accommodate springs **26** and **26'**, respectively, tending to close the jaws. Blocks **9** and **30** are controlled by a common pair of levers **16**, **16'** whose pivotal shaft **16***a* is journaled in bearings **22***c* (only one shown); an arm **22** on shaft **22***b* carries a roller **22***a* co-acting with a cam **21** on shaft **20***a* to open block **9** and to close block **30** against the force of a pair of springs **42**, **42'**.

Pivoted on die member **30***b* by means of a pin **24***b* is a bell-crank lever **24** whose lower extremity carries a roller **24***a* co-operating with a cam **23**; this cam is fixed to the same shaft **20***a* as cam **21** and is driven by the sprocket **20**. Shaft **20***a* also carries a second sprocket **20***c* connected through a chain **13'** with a sprocket **44** on a shaft **44***a*, the latter carrying a cam **27**. A further bell-crank lever **28** has a fixed fulcrum **28***b* and bears a roller **28***a*, the roller being pressed against the periphery of cam **27** by the weight of the block **32** with whose lower jaw **32***a* the free end of lever **28** is connected through a rod **29**. Upper jaw **32***a* carries a roller **25** resting on the bifiurcate upper extremity **24***c* of lever **24**.

The main folding section of the machine, illustrated in Figs. 4–8, operates in the following fashion: The longitudinal folds of the preformed sheet material **1**, coming from roller dies **5**, **6**, **7** and **8** (Fig. 2), are engaged by the serrations *x* of feeding block **9** and carried forward a distance 2*w* by this block as the latter is displaced along the rods **9***c* and **9***c'*. Just before this engagement of the material **1** occurs, block **9** is located at an extreme position close to the last-stage preforming rollers **8**, with jaws **9***a* and **9***b* open to receive the prefolded material. This is illustrated in Figs. 4 and 5 showing the cam **21** so positioned that counterclockwise rotation of arm **22** will occur only after the hump **10***a* of cam **10** has raised the roller **11** against the action of its restoring spring **11***a*. The resulting counterclockwise tilting of levers **16** and **16'** reduces the compression of cushioning springs **19**, **19'** upon a pair of sliding rails **17**, **17'** bearing upon two rollers **18** (only one shown) on jaw **9***a*, thereby enabling a pair of compression springs **43** located in posts **15** and **15'** to raise upper jaw **9***a* from its seat on lower jaw **9***b*. The dwell **21***a* of cam **21** is wide enough to keep jaws **9***a*, **9***b* open until spring **11***a* has returned the block **9** to its rear position (Figs. 1, 6 and 8). Thereupon, another lowering of jaw **9***a* causes the feeding block **9** to engage tightly the strip **1** of prefolded material in the interlocking serrations *x* at a location spaced by the stroke length 2*w* from the point of previous engagement. At the same time the block **30** opens to release the sheet **1** from its serrations *x'*, preparatorily to another forward move of the sheet on the next leftward stroke of block **9** under the control of cam **10**.

The sheet **1**, stiffened by virtue of its longitudinal corrugations, advances between the open jaws **30***a*, **30***b* and **32***a*, **32***b* as feeding block **9** moves toward the left. As soon as block **9** has reached its foremost position as illustrated in Fig. 5, roller **24***a* drops from the high point of its cam 23 to the lower peripheral portion of the cam so that lever **24**, yielding to the pressure of springs **26** and **26'**, allows the jaws **32***a*, **32***b* to close. Shortly thereafter, as seen in Fig. 5, the dwell **21***a* of cam **21** acts upon the linkage **22**, **16**, **16'** to close the jaws **30***a*, **30***b* and to open the jaws **9***a*, **9***b* preparatorily to the return stroke of the jaws **9***a*, **9***b* preparatorily to the return stroke of the block **9**. Thus, the sheet **1** is now clamped by blocks **30** and **32** at two locations longitudinally separated by a zone of length *w* (measured in the direction of advance of advance of the sheet).

At this instant, the reverse-pleating operation begins as cam **27**, engaging roller **28***a*, rotates to a position shown in Fig. 6 so that bell-crank lever **28** pivots in a counterclockwise direction about its fulcrum **28***b* and rod **29**, connected to it at **28***c*, tends to move reversing block **32** horizontally to the right. At the same time, link **35** pivots about pins **35***a* and **35***b*, rotating from a horizontal to a vertical position and thus translating the horizontal motion of reversing block **32** into a climbing curve which combines both horizontal and vertical motion. During this operation, the portion of sheet material of length *w* immediately to the left of supporting block **30** is being carried upwards in such fashion that its corrugations are between serrations *y* of jaws **30***a* and *y'* of jaw **32***b*, i.e. the furrows of the original folded material are transformed into ridges and vice versa. Simultaneously, the interlocking of these serrations produces transverse folds F', F'' (Fig. 9) across the width of the material, separating successive sections X and Y of length *w* whose corrugations are in phase opposition to each other.

The pleated material shown in Fig. 9 may be subjected to longitudinal pressure to cause an interleaving of the corrugations of adjacent sections X, Y so as to form a chevroned structure **1'**, as illustrated in Fig. 10. This chevroned structure may also be bent along an axis to form a pleated cylinder **1''** as shown in Fig. 1 where a cylindrical casing **34**, of radius *w*, is positioned to receive the oncoming sheet material **1** through a peripheral slot **34***a*; the material then abuts a stop **34***b* within the casing so that, as more and more pleated sections are fed into the casing, the sheet folds itself along crease lines F', F'' (Fig. 9) into the cylindrical body **1''**. After this body has reached a predetermined density, e.g. after the completion of a certain number of operating cycles by the mechanism of Fig. 8, the sheet may be cut by suitable means not shown and removed (e.g. by an air blast) from the casing **34** whereupon the production of another pleated cylindrical body may be started. It may be mentioned that the angle of fold at the crease lines F', F'' of the uncompressed structure **1'** may be modified by making the die members **30***a*, **32***a*, **32***b* of generally rhombic, rather than square or rectangular, cross-section so that the toothed faces *x*,'' and *y*, *y'* thereof will lie in planes that are not exactly perpendicular to each other.

A cylinder such as the one shown at **1''**, made from paper or similar sheet material, is particularly useful as a filter for oil and other fluids.

The invention, accordingly, is not limited to the specific embodiments described and illustrated but may be realized in numerous adaptations and modifications without departing from the spirit and scope of the appended claims. For example, hydraulic, magnetic, or electrical means

may be used in place of or in combination with the actuating mechanism specifically disclosed.

I claim:

1. A process for pleating a sheet of pliable material, comprising the steps of forming a series of longitudinal corrugations in said sheet and intermittently reversing said corrugations along transverse sections of limited width.

2. A process according to claim 1 wherein said sections are all of the same width.

3. A process according to claim 2, comprising the further step of zig-zag-folding said sheet about transverse lines separating said sections from one another.

4. A process according to claim 3, comprising the further step of exerting sufficient longitudinal pressure upon the folded sheet to interleave the corrugations of adjacent sections.

5. A process according to claim 1 wherein said corrugations are produced by the formation of progressively deepening longitudinal creases in said sheet.

6. An apparatus for converting a flat sheet of pliable material into a chevroned structure, comprising profiled first die means adapted to form longitudinal corrugations in said sheet, profiled second die means positioned beyond said first die means and in alignment therewith, said second die means having a profile substantially reversed with respect to that of said first die means, feed means for advancing said sheet successively past said first and second die means, and operating means for actuating said first and second die means in timed relation to the operation of said feed means so that longitudinally adjoining sections of said sheet will be formed with relatively inverted corrugations.

7. An apparatus according to claim 6 wherein said first die means comprises a plurality of roller pairs positioned transversely to the direction of advance of said sheet, said roller pairs being provided with peripheral ridges and depressions of progressively increasing depth.

8. An apparatus according to claim 7 wherein the spacing of said ridges from one another is progressively smaller for successive roller pairs.

9. An apparatus according to claim 7 wherein said first die means further includes a pair of co-operating feeding blocks positioned beyond the last of said roller pairs and having ridges and depressions substantially coextensive with those of said last roller pair.

10. An apparatus according to claim 9 wherein said operating means includes mechanism for reciprocating said feeding blocks in the direction of advance of the sheet, said mechanism including means for clamping the sheet between said blocks during the forward stroke thereof and releasing the sheet during the return stroke.

11. An apparatus according to claim 10 wherein said second die means comprises a pair of co-operating reversing elements positioned beyond the forward limit of the stroke of said blocks, said operating means including

mechanism for bringing said reversing elements close together against the sheet in the released position of said feeding blocks.

12. An apparatus according to claim 11 wherein the width of said reversing elements is substantially half the length of the stroke of said feeding blocks.

13. An apparatus according to claim 11 wherein said first die means further comprises a pair of retaining blocks positioned adjacent the forward end of the stroke of said feeding blocks, said retaining blocks having profiled faces aligned parallel to the direction of advance of the sheet, said reversing elements including a further profiled face on one of said retaining blocks extending at as angle to said direction of advance, and an additional profiled block swingably mounted adjacent said further face for clamping said sheet between the latter and itself.

14. An apparatus according to claim 6, further comprising a hollow cylinder positioned beyond said die means for receiving the corrugated sheet, said cylinder having a radius exceeding the width of said sections and being provided with an internal abutment for arresting the oncoming sheet and zig-zag-folding the sections of said sheet within said cylinder.

15. In a corrugating machine, in combination, a first die comprising a pair of jaws having flat faces with mating teeth defining a serrated profile, a second die comprising a pair of jaws having flat faces with mating teeth defining a serrated profile in phase opposition to that of said first die, and mechanism for intermittently urging one of the jaws of each die toward the associated jaw of the same die and against adjacent sections of a pliable sheet inserted therebetween.

16. The combination according to claim 15 wherein said dies include a common block, one of the faces of said first die and one of the faces of said second die being provided on adjacent sides of said block.

17. The combination according to claim 15, further comprising pre-folding means including a pair of forming elements provided with teeth forming a profile substantially coextensive with that of said first die, said elements being positioned forwardly of said first die for imparting continuous longitudinal corrugations to said sheet.

18. The combination according to claim 15, comprising a third die including a further pair of jaws positioned beyond said second die, said further pair having mating serrations defining a profile corresponding to that of said first die, and operating means for advancing a sheet section previously engaged by said first die past said second die and into operative engagement with said third die.

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Disclaimer

2,901,951.—*Henry Hochfeld*, New York, N.Y. PROCESS AND MACHINE FOR PLEATING PLIABLE MATERIALS. Patent dated Sept. 1, 1959. Disclaimer filed Sept. 7, 1962, by the inventor.

Hereby enters this disclaimer to claims 4, and 6 to 18, inclusive, of said patent.

[*Official Gazette October 16, 1962.*]

Notice of Adverse Decision in Interference

In Interference No. 92,500 involving Patent No. 2,901,951, H. Hochfeld, Process and machine for pleating pliable materials, final judgment adverse to the patentee was rendered Nov. 14, 1962, as to claims 1, 2, 3 and 5.

[*Official Gazette February 5, 1963.*]