

Sept. 6, 1949.

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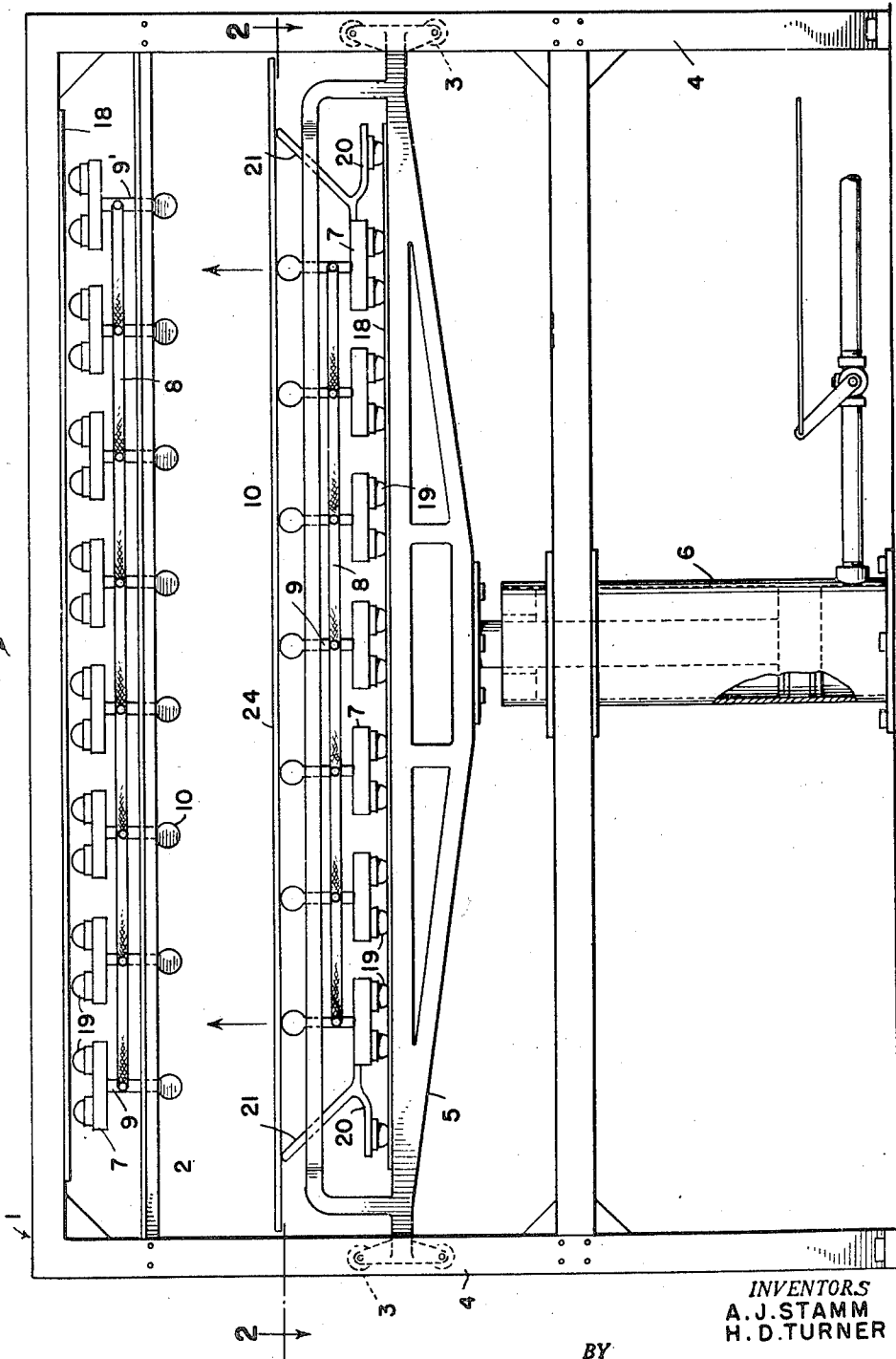
2,481,049

APPARATUS FOR CORRUGATING SHEET MATERIAL

Filed April 16, 1947

5 Sheets-Sheet 1

Fig. 1.



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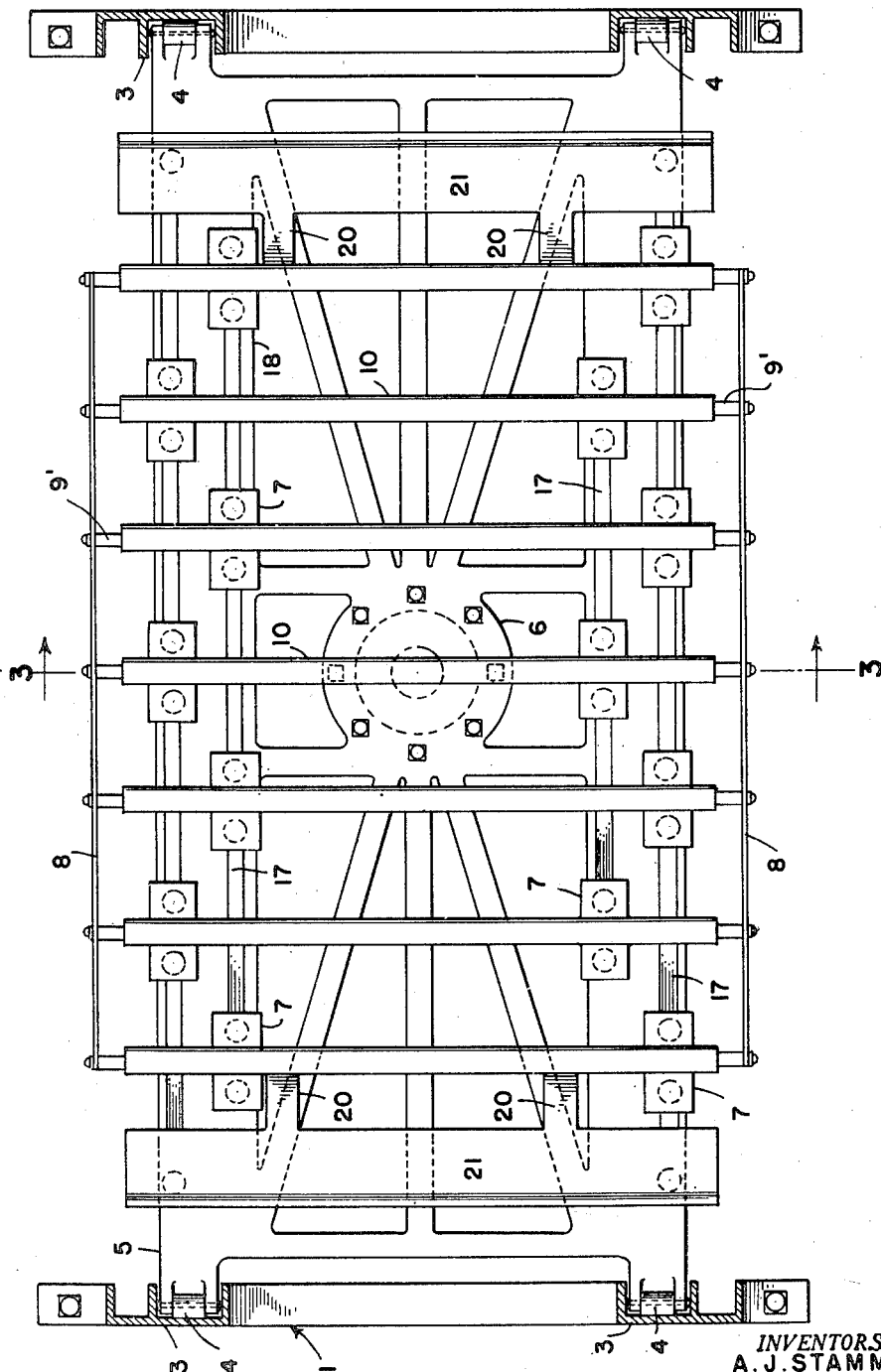
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5 Sheets-Sheet 2

Fig. 2.



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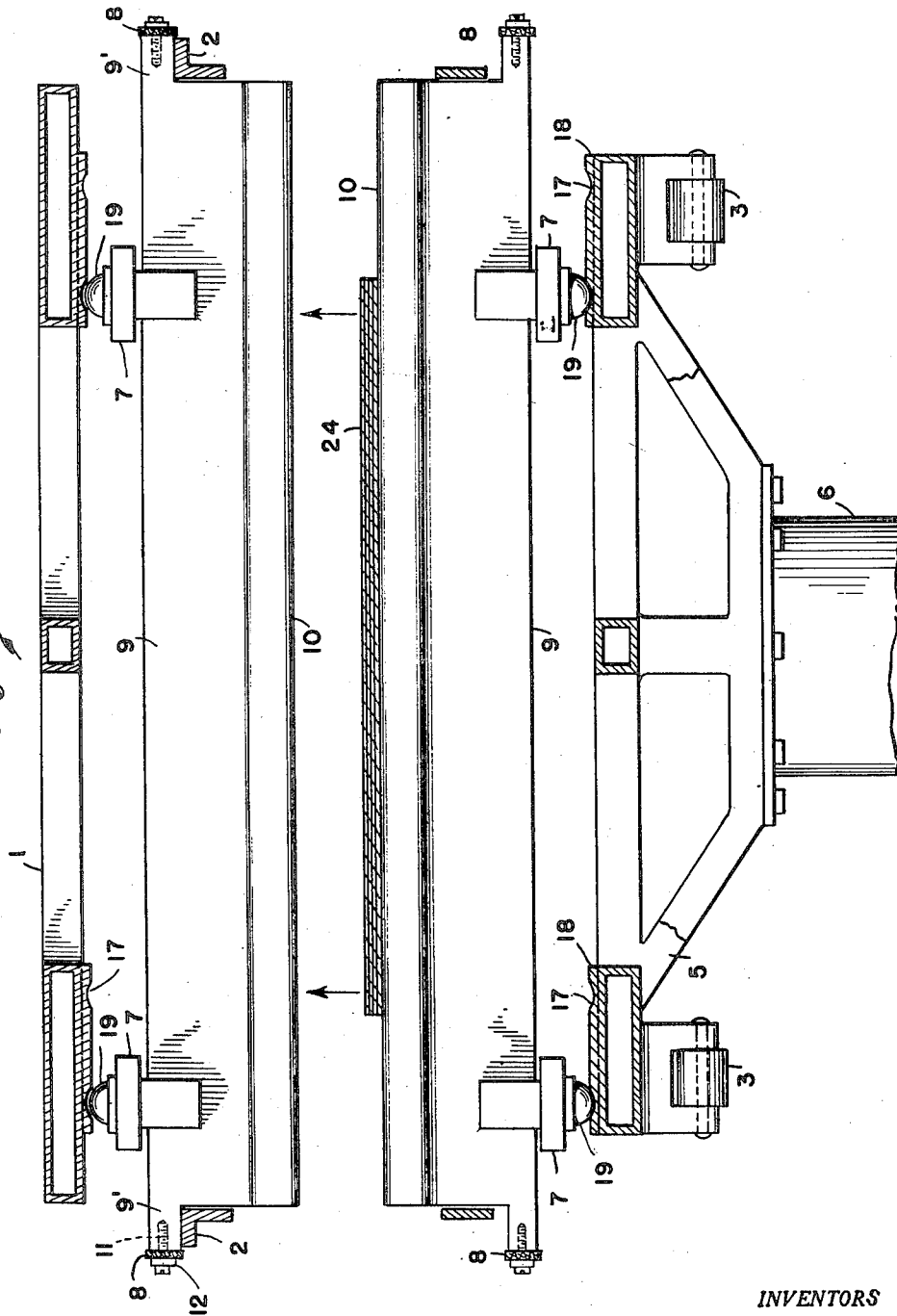
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5 Sheets-Sheet 3

Fig. 3.



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5 Sheets-Sheet 4

Fig. 4.

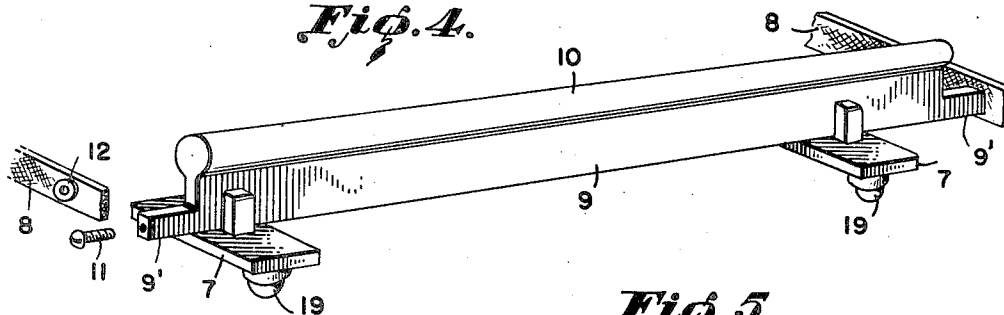


Fig. 5.

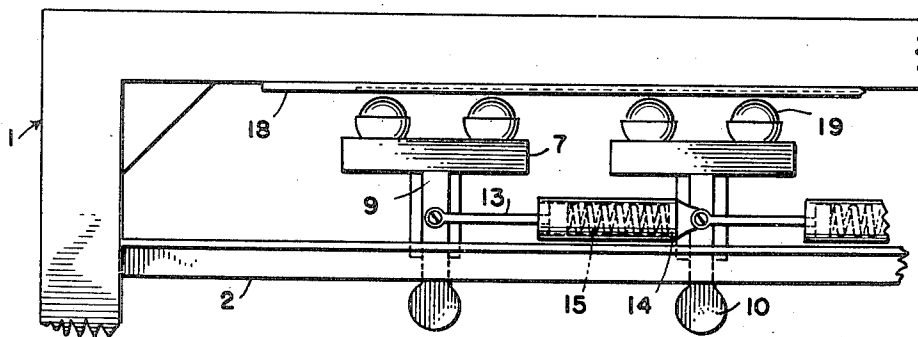
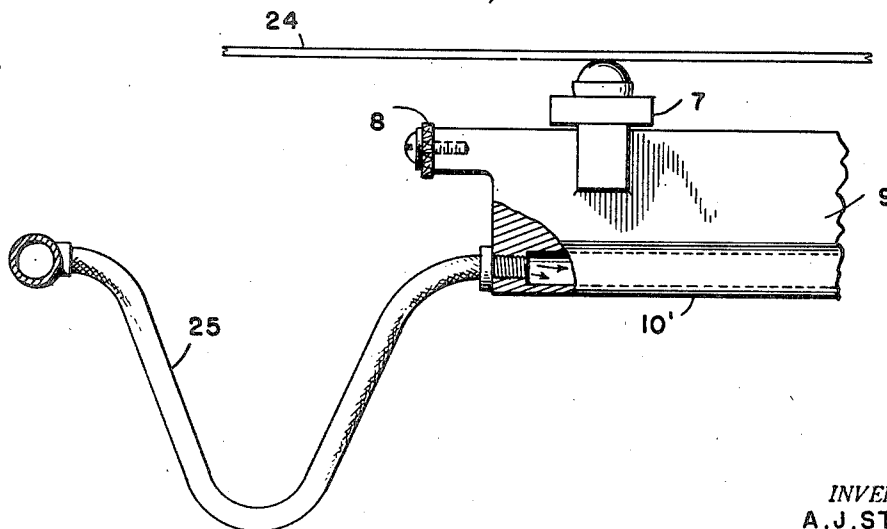


Fig. 6.



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5 Sheets-Sheet 5

Fig. 7.

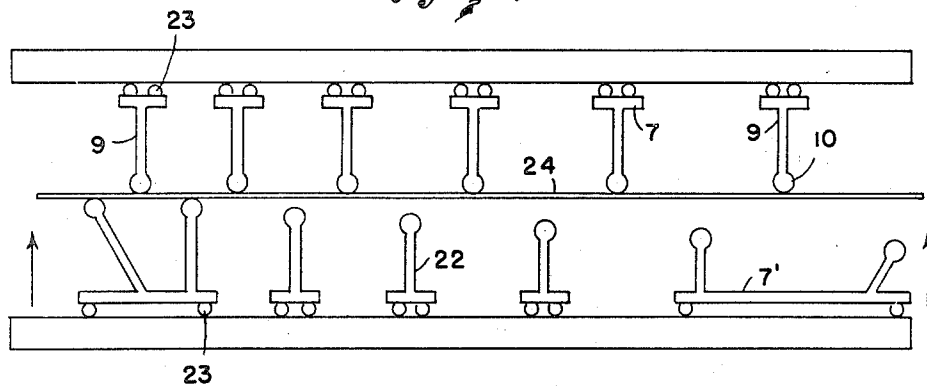


Fig. 8.

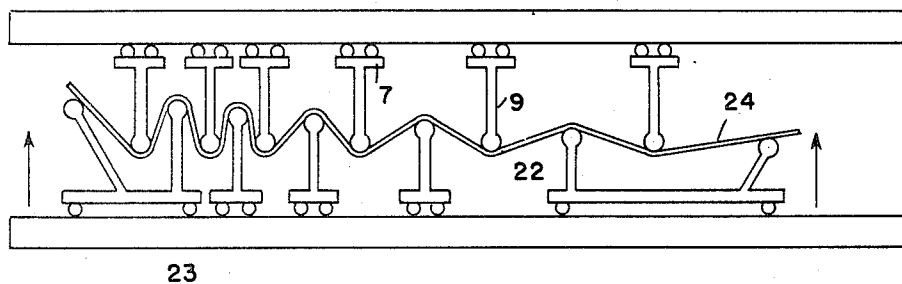
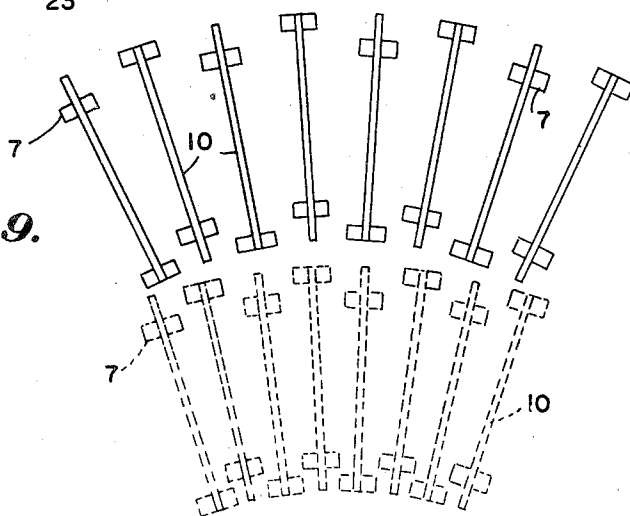


Fig. 9.



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UNITED STATES PATENT OFFICE

2,481,049

APPARATUS FOR CORRUGATING SHEET MATERIAL

Alfred J. Stamm and Harold Dale Turner, Madison, Wis.; dedicated to the free use of the People in the territory of the United States

Application April 16, 1947, Serial No. 741,832

9 Claims. (Cl. 154—30)

(Granted under the act of March 3, 1883, as amended April 30, 1928; 370 O. G. 757)

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This application is made under the act of March 3, 1883, as amended by the act of April 30, 1928, and the invention herein described, if patented, may be manufactured and used by or for the Government of the United States of America for governmental purposes without the payment to us of any royalty thereon.

We hereby dedicate the invention herein described to the free use of the people in the territory of the United States to take effect on the granting of a patent to us.

This invention relates to a method and apparatus for corrugating sheet material, such as plywood, veneer, laminated plastics, sheet plastic, or metal sheets, with minimum of tensile stresses. An object of this invention is to corrugate fragile or refractory materials, that cannot withstand present methods of corrugating, by subjecting such fragile or refractory materials to bending forces, without stretching or drawing.

A further object is an apparatus for forming multiple corrugations in such materials simultaneously. Some materials must be held in the deformed state for an appreciable interval of time before the wave form becomes stabilized. Veneer or plywood deformed in a water-soaked condition must be dried to stabilize the corrugations. Sheet plastic made flexible by heat must be cooled to hold the deformed shape. Sheet fibrous materials impregnated with thermosetting resin must be cured in the deformed shape in order to retain the corrugation. Since our preferred method forms the multiple corrugations simultaneously, the deformed material may be held for stabilization of its form for a considerable time economically, all of the corrugations being simultaneously held for stabilization of form.

Another object is a process that permits the production of a variety of corrugated or wave forms by means of a single apparatus. Corrugations varying in wave length or amplitude, or both, can be readily made by the same apparatus with minor adjustment and replacement of parts.

The said objects are attained by pressing the sheet between two banks of interdigitating press members or mandrils, which latter are, preferably, each individually free to move transversely to the corrugations, by the lateral impulsion of the sheet being corrugated.

We shall now proceed to describe the invention with reference to the accompanying drawing, wherein:

Figure 1 is a front elevation of one form of the invention;

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Figure 2 is a top view of the lower mandrils, taken on section line 2—2 of Figure 1;

Figure 3 is a side view taken on section line 3—3 of Figure 2;

Figure 4 is a view of a lower mandril and its supporting carriages;

Figure 5 is a modified form of the positioning means for the carriages;

Figure 6 is a modified form of the mandril head, providing for heating means.

Figure 7 is a diagrammatic front view of a modified form of the device in position to corrugate a sheet;

Figure 8 is another view of the apparatus of Figure 7, after or during the corrugating operation;

Fig. 9 is another modification, for fanlike corrugation.

The apparatus shown in Figures 1 to 4 comprises a framework 1, having attached thereto a fixed supporting bracket 2 for the upper row of mandril, and providing a track 3 for wheels 4 attached to the ends of the lower movable platen 5 of a hydraulic press 6. Platen 5 supports a series of mandril carriages 7 each of which is free to move toward the center, that is, toward the central carriage in Figure 1. Movement outward from the center may be limited by the removable limit tapes 8, use of which is optional. Fixedly or removably attached to each carriage is a vertical mandril bar 9 carrying a mandril head 10 which head may be hollow, as shown in Figure 6 at 10', to permit introduction of heating or cooling fluid, for example by means of the flexible conduit 25. Limit tapes 8 may be attached to the mandril bars 9 by screw bolts 11 and washers 12, or by snap fasteners (not shown), to space the mandril bars at equal or unequal distance apart. The limit tapes may be replaced by the piston 13, cylinder 14, and spring 15 arrangement between the carriages, shown in Figure 5. The light springs serve to restore the mandrils to open position. Any convenient mechanical or electrical arrangement may be furnished to cause the upper and the lower mandrils to separate to the limits set by the limit tapes, upon completion of the corrugation and lowering of the platen 5. For example, cords attached at one end to each end of the lower limit tapes, passed under pulleys mounted on the ends of the platen, and attached at the other ends to the frame 1, would serve to separate the lower mandrils. Similar cords attached at one end to each end of the upper limit tapes, passing over pulleys mounted on the frame 1, and

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attached to the other end to the platen, would separate the upper mandrils. Since such means and the equivalents are obvious to mechanics it is not shown on the drawings.

The carriages 7 shown in Figure 4 are mounted on spherical balls 19, two for each carriage being provided. The balls of the lower carriages roll in groove tracks 17 (Figs. 2 and 3) in the plates 18 that are fixed upon the movable platen 5. As shown in Figure 2, a view looking downward upon the lower mandril assembly, the carriages of adjacent mandrils are staggered, the traction balls of the adjacent carriage moving in a separate groove track 17. This staggered arrangement permits wider lateral movement of the mandrils without interference between adjacent carriages. Two lower groove tracks 17 are shown at each side.

The end carriages of the lower mandril assembly are modified forms. As shown in Figures 1 and 2, each of these end carriages has an extension bracket 20 supported by a third traction spherical ball. Fixedly mounted upon the two extension brackets is an end angular mandril bar 21 which may or may not carry a mandril head. In the drawings is shown a flat mandril bar with no mandril head. Angularly mounted mandril bar 21 moves inwardly at the same rate as the adjacent vertical mandril on the same carriage and is so located that its point of contact with the sheet to be corrugated lies beyond the contact point of the end mandril on the fixed upper head. By this means all of the vertical mandrils have essentially balanced forces acting upon them and they do not tip as they move inwardly during the corrugation operation. The extended supporting brackets prevent tipping.

The upper mandril units are similar to the central lower mandrils, being supported by the carriages 7 having traction spherical balls 19. The carriages are free to move laterally along groove tracks 17 formed in the upper part of frame 1, the pressure head. Adjacent carriages are staggered as in the lower mandrils. As shown in Figures 1 and 3, the flanges 9' of the upper mandril bars rest upon and are suspended on the frame brackets 2 when the mandrils are in open position. In this position the roller casters or balls are only a fraction of an inch removed from the groove in which they roll when a sheet is being corrugated. When the mandrils come in contact with the sheet to be corrugated, they are lifted slightly away from the support bracket 2 until the balls make contact with the bed rail or groove track. The lift or movement is from about 0.020 to 0.100 inch.

Since the mandrils are independent units they can be readily spaced to yield corrugations of variable wave length. The depth of the corrugation can be adjusted by employing stops of variable length between the compression plates. The mandril stems or bars may be made demountable and exchangeable for stems of shorter or longer length. The stems employed in a corrugation operation may be equal in height, as shown in Figures 1 and 2, or they may vary in height.

In Figures 7 and 8 the upper set of mandrils 9 is of uniform height, whereas the lower set 22 is non-uniform in height. The terminal mandril on the left end of the lower bank is the only fixed mandril; the others are free to move according to the contraction required by the formation of the wave. The mandrils are not pushed by an external force, but are caused to move by the corrugated sheet being formed. The formation of

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the corrugated sheet naturally causes the mandrils to migrate towards the contracted position. The mandrils move in succession, as they make contact; after which they are all in motion, but at varying rates. In Figures 7 and 8 the upper mandril carriages are similar to those described above. The lower carriages 7 are of unequal width. The traction means 23 may be roller balls as in Figures 1 to 6 or they may be short cylindrical rollers having axes attached to the carriages. As shown in Figure 8, the sheet 24 is corrugated into the form of a damped wave of progressively changing wave length.

Figure 9 illustrates, diagrammatically, a modification in which the lower and upper mandrils are initially placed in open fanwise formation, indicated in full lines. As the corrugated sheet is being formed, the rate of movement of opposite ends of the mandrils will be different. The contracted position of the mandrils after the corrugation operation is shown in dotted lines. Since the rollers are free to move laterally, they will move at the rate and in the direction required by the type of wave being formed. The movement of the rollers is dependent upon their initial placement and upon the deformation of the sheet, no external force being required. The rollers are made to move in an arcuate track so as to retain the fan-shaped arrangement, the mandrils coming closer together in the original plane of the sheet. In this way a fan-shaped corrugated sheet can be made with equal amplitudes and equal wave length between corresponding points on the multiple corrugations, but with varying wave lengths across the width of the sheet.

Whereas, in our preferred form all of the mandrils in each set are actuated in unison, our process and apparatus is readily modifiable to permit the movement of these mandrils in the sequences taught in Mason Patent No. 2,058,334, or Magnani Patent No. 2,210,985, or Fraser Patent No. 2,079,553, by employing the operating mechanisms described in these patents, with minor modification of the connecting rods to permit lateral movement of the mandrils with respect thereto. However, our invention is designed to obviate the need for such complicated operating means.

As indicated above, the mandrils may be made hollow to permit the supplying of heating fluid thereto in a manner well known to the art, being described in the Mason Patent No. 2,058,334.

The mandril heads may be made rotatable, in the form of rolls, to further reduce friction.

The apparatus may be made automatic in operation by means well known to the art, and described in the above-mentioned patents.

Where the corrugations are not formed simultaneously, as in the form shown in Figures 7 and 8, there may be some tendency for tipping of other than the end carriages and a premature movement of the far end carriage, due to the drag of the sheet as it flexes back and forth. Both of these tendencies can be eliminated by using rigid positioning means such as is shown in Figure 5.

Having thus described our invention, we claim:
1. Apparatus for pressing a sheet into corrugated state comprising a set of spaced-apart, longitudinally extending mandrils, supporting carriages for the mandrils, a second set of spaced-apart mandrils, opposite the spaces between the first set, supporting carriages for these mandrils, means carrying one set of carriages, means for moving said carrying means to press one set of

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mandrils against the sheet, a pressure head for the other set of mandrils, rotating traction means interposed between the carriages of one set and the pressure head, and between the carriages of the other set and the carrying means for the latter, the carriages being free to move, on said traction means, along the plane of the sheet, in a direction transverse to the length of the mandrils.

2. The apparatus described in claim 1 in which each mandril comprises a mandril bar supported at each end by a carriage, the rotating traction means being rotatably attached to the carriage.

3. The apparatus described in claim 2 in which the carriages of adjacent mandril bars in each set are offset with respect to each other, to permit movement of adjacent mandrils and carriages toward each other without interference between carriages.

4. The apparatus of claim 3 in which the carriages of adjacent mandril bars in each set move in a common plane, parallel tracks being provided in which the traction means are constrained to move.

5. The apparatus of claim 1 in which each mandril comprises a mandril bar, the bars being of unequal height.

6. The apparatus of claim 1 in which each mandril comprises a mandril bar, the bars of one set being of equal height, the bars of the other set being of unequal height.

7. The apparatus of claim 1 in which the mandrils of each set are positioned fanwise, the carriages being constrained to move in arcuate tracks.

8. A machine for pressing sheet material into corrugated form comprising a set of spaced-apart longitudinally extending press members, a second set of spaced-apart longitudinally extending press members interposable between the first said press members, members in each set being free to move toward each other, transversely to the corrugations, in response to impulsion by the sheet being corrugated and frame means freely supporting each set of members and providing surfaces adapted to apply pressure upon the press members, and anti-friction rotary traction means interposed between the press members and the

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pressure applying surfaces of the frame means to facilitate said freedom of movement in response to impulsion by the sheet being corrugated.

9. Apparatus for pressing a sheet into corrugated state comprising an upper set of spaced-apart, longitudinally extending mandrils; individual supporting carriages for the mandrils; longitudinally extending flanges on the mandrils; frame means to support the flanges; upper frame means having a surface in position to limit upper movement of the said mandrils and carriages; anti-friction ball and socket traction means between the said surface and said mandrils and mounted upon the carriages; a lower set of spaced-apart mandrils, opposite the spaces between the first set; individual supporting carriages for these mandrils; means carrying said second set of carriages; means for moving said carrying means to press said second set of mandrils against the sheet; anti-friction ball and socket traction means interposed between the carrying means and the second set of carriages and mounted upon the carriages; the carriages being free to move, on said traction means, parallel to the plane of the sheet, in a direction transverse to the length of the mandrils in response to tension in the sheet being corrugated; and means connecting adjacent carriages in each set for adjusting the initial distance between carriages before pressure is applied to the sheet.

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