Aug. 13, 1940. A. MAGNANI 2,210,985

METHOD FOR CORRUGATING SHEETS

Filed Aug. 3, 1938 4 Sheets-Sheet 1

Fig. 1,

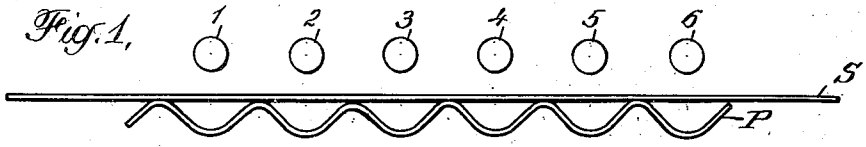


Fig. 2

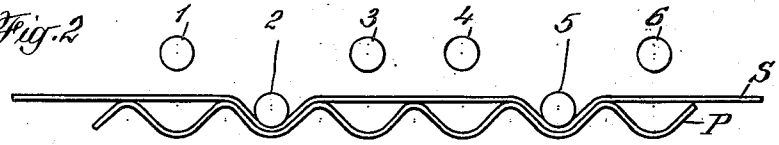


Fig. 3,

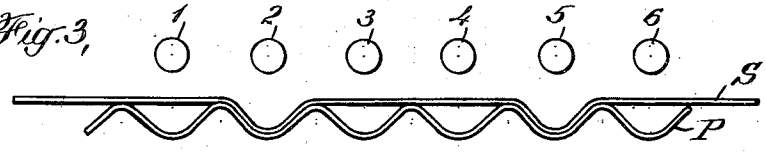


Fig. 4

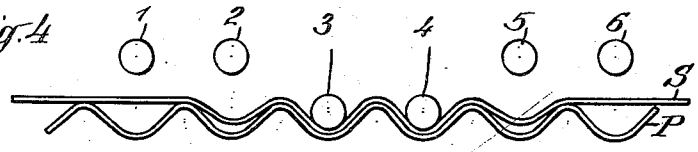


Fig. 5,

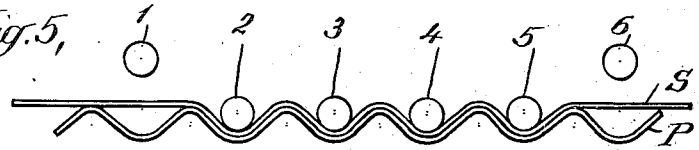


Fig. 6,

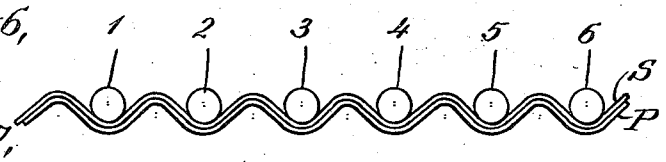
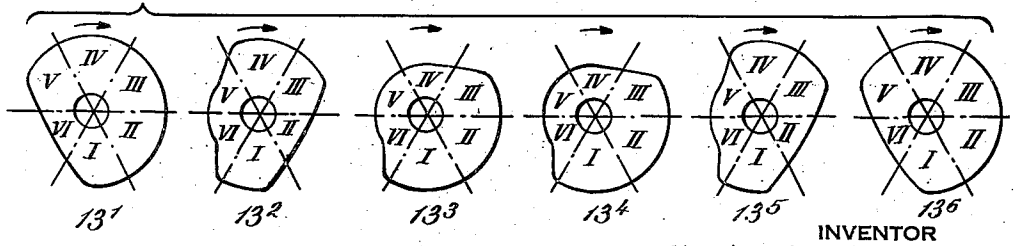


Fig. 7,



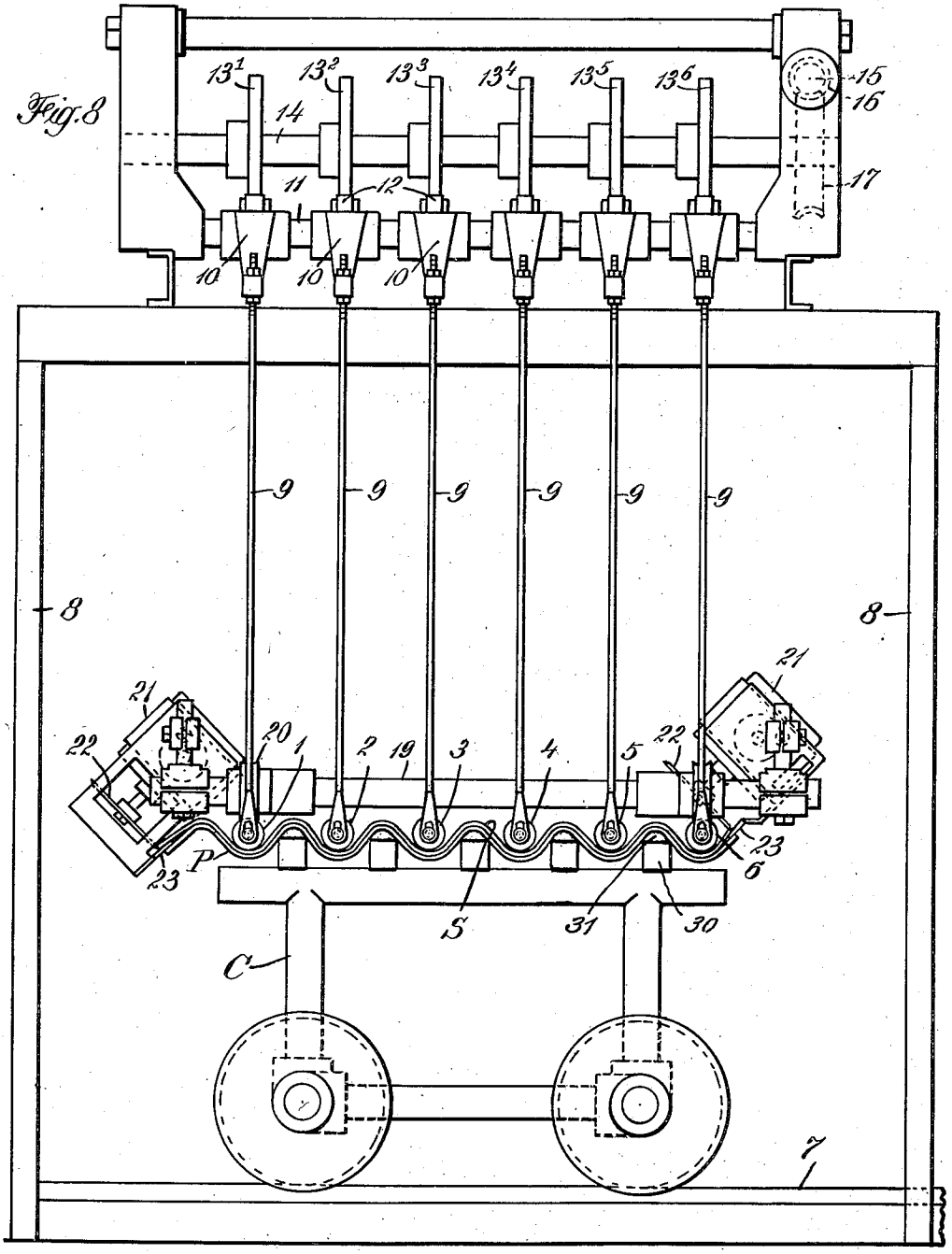
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METHOD FOR CORRUGATING SHEETS

Filed Aug. 3, 1938 4 Sheets-Sheet 2

Fig. 8



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Aug. 13, 1940. A. MAGNANI 2,210,985

METHOD FOR CORRUGATING SHEETS

Filed Aug. 3, 1938 4 Sheets-Sheet 3

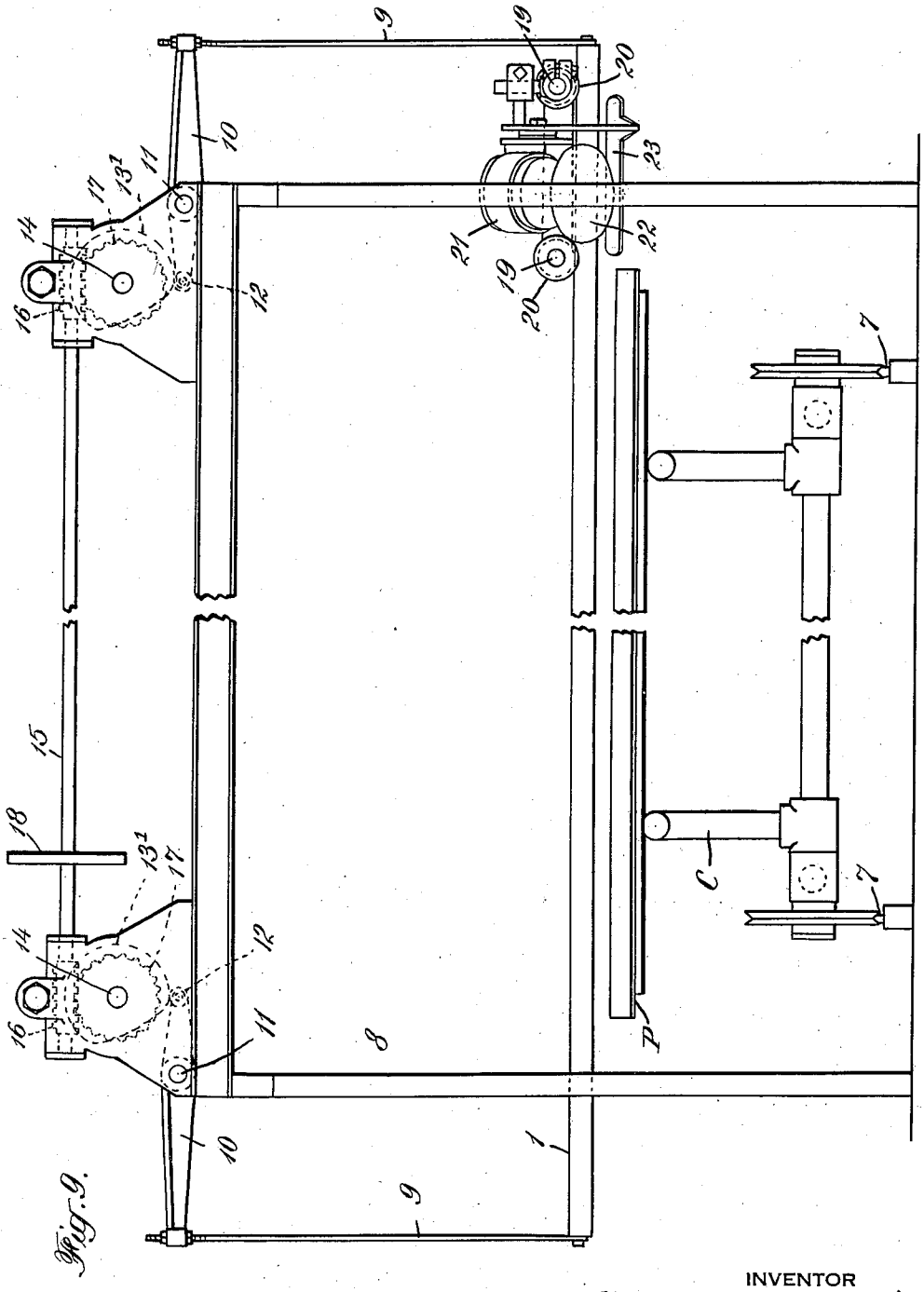


Fig. 9.

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METHOD FOR CORRUGATING SHEETS

Filed Aug. 3, 1938 4 Sheets-Sheet 4

Fig. 10

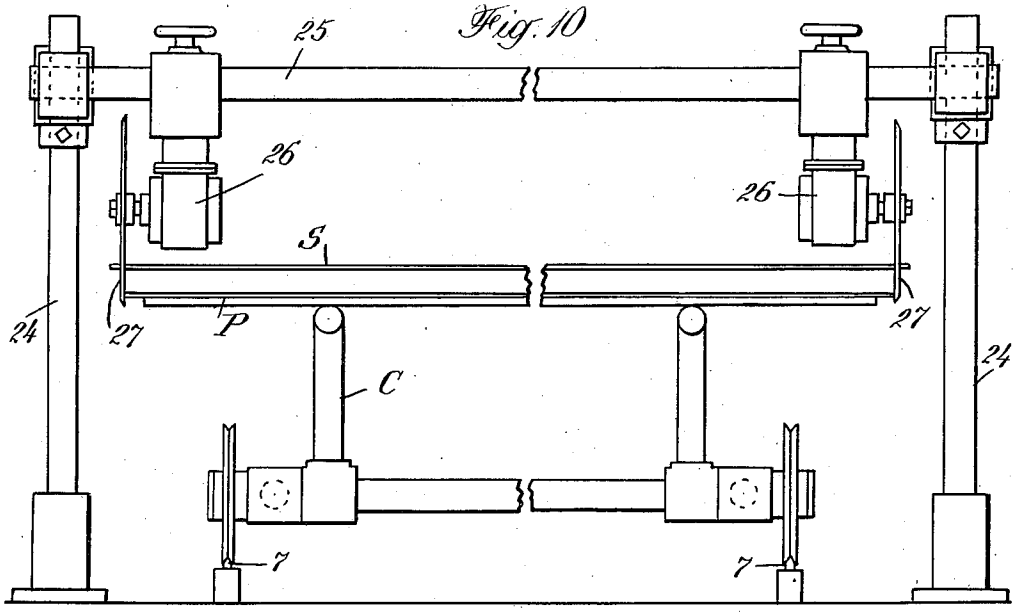
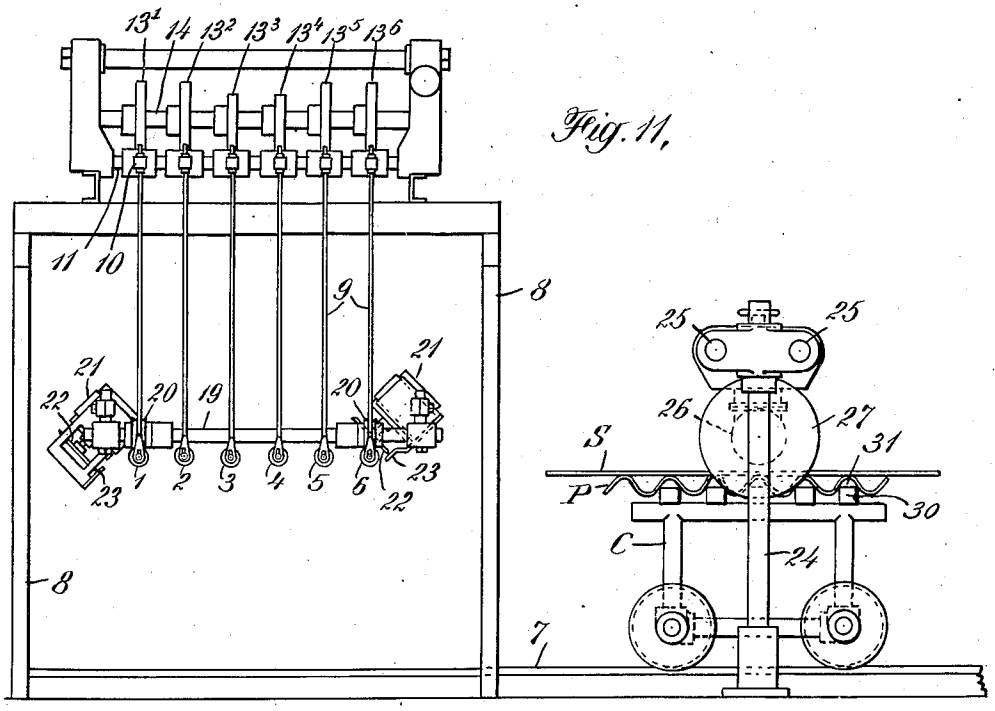


Fig. 11.



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UNITED STATES PATENT OFFICE

2,210,985

METHOD FOR CORRUGATING SHEETS

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Application August 3, 1938, Serial No. 222,777
In Italy August 5, 1937

7 Claims. (Cl. 154—33)

This invention relates to corrugating plastic sheets, such as those made from hydraulic cement mixed with a fibrous substance. Corrugated sheets of this kind have found extensive use particularly in the building industry for roofing, wall-sheathing, and the like.

Heretofore the corrugating of the plastic sheets has sometimes been done by hand, the sheet being molded on a corrugated form, or platen, by means of hand operated rolls. Such manual molding is likely to cause cracks and tears in the weak plastic sheet so that the finished article is unsatisfactory, and considerable waste is occasioned.

Corrugating of the plastic sheets has also been done mechanically by a series of parallel rolls which are lowered to press the sheet into the corrugations of the platen, but the rolls have acted on the sheet simultaneously to form all of the corrugations in the sheet at one time. It has been proposed to cause the middle roll, or middle group of rolls, to act on the sheet first and thereafter to cause the remaining rolls to act simultaneously to form the other corrugations in the sheet. It has also been proposed that after the middle rolls act on the sheet the remaining rolls shall act successively and progressively on the sheet from the median portion thereof toward its opposite edges. All of these mechanical systems are open to the objection that during the corrugating operation the weak plastic sheet is subjected to considerable tension and stretching, or to a relatively large amount of transverse shifting at some stage of the operation, or to a pulling on a relatively wide portion of the sheet, or to all these things in combination, with consequent danger of disrupting the fragile sheet.

According to the present invention the corrugating of the plastic sheets is done mechanically by automatic machinery but with such precision and in such a way as to materially reduce at each stage of the operation, the stretching and tensile strains in the plastic sheet, the amount of transverse shifting of the sheet, and the width of any flat portion of the sheet that has to be pulled upon when the corrugations are formed.

This is accomplished by supporting the flat sheet, while still in a plastic condition, on the usual corrugated form, or platen, above which are mounted a series of parallel molding rolls which are capable of being lowered and raised individually and independently of one another to press portions of the sheet into the corrugations of the platen and thereby corrugate the sheet. Means are provided for operating the rolls so that the rolls located between the middle ones and the extreme ones are first lowered and then raised, then the middle rolls are lowered and while they remain lowered the first lowered rolls are again lowered and while all of the rolls thus far referred to remain lowered the extreme rolls are lowered. In this way the above mentioned objections to previously proposed methods are overcome for the reasons hereinafter explained.

The corrugated form, or platen, is mounted on a movable carriage which is adapted to travel under a frame carrying rotary trimming knives whereby the edges of the sheet may be trimmed which are parallel with the direction of movement of the carriage and at right angles to the corrugations to be formed in the sheet. For trimming the edges of the sheet which are parallel with the corrugations formed in the sheet there is preferably provided a trimming carriage which is mounted on the extreme rolls of the molding mechanism so as to be movable longitudinally along them whereby after these extreme rolls are lowered to form the final corrugations in the sheet the carriage may be moved along the rolls to cause rotary trimming knives mounted on the carriage to trim the edges of the sheet along the outside corrugations.

One form of apparatus constructed in accordance with the invention and capable of carrying out the improved method is disclosed in the accompanying drawings, in which:

Figures 1 to 6 inclusive are explanatory diagrams showing the sequence of operation of the forming rolls;

Fig. 7 shows the contour of the cams employed for permitting the rolls to lower and for raising them;

Fig. 8 is an end elevation of the forming mechanism, of which the rolls form a part, and the trimming mechanism for trimming the edges of the sheet which are parallel with the corrugations. This figure also shows the platen-carriage under the forming rolls;

Fig. 9 is a side elevation of the mechanism shown in Fig. 8;

Fig. 10 is a front elevation of the trimming mechanism for trimming the edges of the sheet which are at right angles to the corrugations; and

Fig. 11 is an end elevation showing a relationship between the forming mechanism and the trimming mechanism of Fig. 10 such that the platen-carriage may be moved from a position under the forming mechanism to a position under the trimming mechanism and vice-versa.

Referring first to Figs. 1 to 6, the sheet S to be corrugated, which may be a sheet of asbestos-

cement that is still wet and plastic, is supported on a corrugated form or platen P. The forming or molding rolls are indicated at 1, 2, 3, 4, 5 and 6. They are of the proper size to be received by the corrugations in the platen, are arranged in parallel relation, and are spaced apart in accordance with the spacing of the corrugations in the platen. When the platen is moved under the series of rolls, as hereinafter described, each roll in descending will press a portion of the sheet into one of the corrugations of the platen and thereby form a corrugation in the sheet.

In the normal position of the rolls they are all in the raised position as shown in Fig. 1. The rolls are so operated that those indicated at 2 and 5 are first lowered, preferably simultaneously, to form corresponding corrugations in the sheet as depicted in Fig. 2. This operation causes only a slight inward shifting of relatively narrow edge portions of the sheet which lie outward of these rolls. These rolls are then raised so that all of the rolls are again in their raised position as shown in Fig. 3. The middle rolls 3 and 4 are then lowered, preferably simultaneously, this step being depicted in Fig. 4. This forms in the sheet the two middle corrugations, the forming of which partially straighten out the first formed corrugations. While the rolls 3 and 4 remain lowered the rolls 2 and 5 are again lowered as shown in Fig. 5 to complete the molding of the corresponding corrugations in the sheet. While rolls 2, 3, 4 and 5 remain lowered the extreme rolls 1 and 6 are lowered as shown in Fig. 6 to form in the sheet the end corrugations. This operation causes only a slight inward movement of the extreme marginal portions of the sheet. All of the rolls are then returned to the initial raised position shown in Fig. 1.

If all of the rolls were lowered simultaneously tensile strains would be produced in the sheet across the ridges of the corrugations and the corrugations would be formed as a result of the stretching of the sheet and possibly as a result of considerable inward movement of the two halves of the sheet. This would reduce the thickness of the material and there would be great danger of tearing the weak plastic sheet. If the middle rolls were lowered first, followed by a lowering of the other rolls either simultaneously or successively from the median line of the sheet toward its outer edges, relatively wide uncorrugated side portions of the sheet would be pulled inwardly and shifted across the ridges of the corrugations in the platen and the resulting friction and tensile strains produced in the sheet would be likely to disrupt the sheet. If the rolls were progressively lowered from the extreme ones toward the middle ones, the middle part of the sheet would be considerably stretched when the first corrugations are formed so that difficulty would be encountered in forming the intermediate corrugations without disrupting the sheet. These troubles are eliminated by lowering the rolls in the sequence above described. When the first two corrugations are formed by the rolls 2 and 5 the middle portion of the sheet lying between them is not stretched enough to interfere with the successful formation of the two middle corrugations and only approximately one-fourth of the sheet is pulled inwardly a relatively small amount over the corrugations of the platen. If the middle rolls were first lowered, approximately one-half of the sheet would have to be pulled inwardly over the corrugations of the mold. When the middle rolls 3 and 4 descend there is very little shifting of the sheet and the material is subjected to but little strain. When the extreme rolls 1 and 6 are lowered there is a pull on only very narrow marginal portions of the sheet and the strains produced therein are practically negligible. Thus at every step there is a pull on only a relatively narrow portion of the sheet which moves but a slight distance inwardly over the corrugations of the platen and violent jerking and pulling on relatively wide heavy portions of the sheet such as might disrupt it are eliminated.

While six rolls have been shown for forming six corrugations in the sheet, it is obvious that the principle is applicable to five rolls, in which case there would be only one middle roll, namely, the third of the series. In that case the second and fourth rolls of the series would be lowered first and then raised, then the middle roll of the series would be lowered, then the second and fourth rolls would be lowered again and finally the extreme rolls would be lowered. Likewise, the number of rolls in the series may be increased, if desired, any rolls located outward of rolls 1 and 6 shown in the drawing being simultaneously lowered with the rolls 1 and 6 or lowered subsequent thereto.

As a preliminary step before the sheet is corrugated, or as a final step after the corrugations have been formed in the sheet and the edges of the sheet along the outside corrugations have been trimmed, the sheet may be passed by trimming mechanism which trims the edges of the sheet that are at right angles to the corrugations. After the corrugations have been formed in the sheet the edges of the sheet which are parallel with the corrugations are trimmed by mechanism which is preferably associated with that part of the apparatus of which the forming rolls form a part.

One form of complete apparatus for corrugating and trimming the sheet will now be described.

The form of platen P is mounted on a travelling carriage C as shown in Figs. 8, 9 and 10. The carriage preferably moves on a track 7 passing under a frame work 8 which supports the forming rolls 1–6 and the mechanism which operates them. Each of the forming rolls is rotatably mounted at its extremities in the lower ends of a pair of rods 9 (Fig. 8 and 9). By rotatably mounting the rolls frictional rubbing of the surface of the rolls against the surface of the sheet material is avoided but they may be rigidly mounted on the rods 9 if so desired. Each rod 9 is connected at its upper end to the outer extremity of an arm 10 which is pivotally mounted intermediate its ends on a shaft 11 supported by the frame 8. The inner end of the arm 10 carries a cam roller 12 which bears on the edge of one of a series of cams mounted on a cam shaft 14 which is also supported by the frame work 8. It will be understood that there is a cam shaft at each end of the frame 8 running at right angles to the forming rolls and that each forming roll is operated by two similar cams, one located on one cam shaft and the other located on the second cam shaft and that the arm 10 is likewise duplicated at each end of the machine. There are six cams on each cam shaft shown at 13^1, 13^2, 13^3, 13^4, 13^5, and 13^6 in Fig. 8. Thus the two cams 13^1 operate the forming roll 1 and the two cams 13^2 operate the forming roll 2, and so on. The two cam shafts 14 are simultaneously driven from a drive shaft 15 through worms 16 mounted on the ends of the shaft 15 and wormwheels 17 mounted on the cam shafts 14. The shaft 15 may be ro-

tated in any suitable way as by a belt passing around the pulley 18 thereon.

When the cam rolls 12 on the pivoted arms 10 are in contact with the high points of the cams the forming rolls are in their raised position. When the low points of the cams come opposite the cam rollers 12 the forming rolls descend by their own weight.

The contour of the cams is illustrated in Fig. 7. It will be understood that all of the cams shown in this figure are mounted on one shaft but are represented in a horizontal row in this figure to more clearly show the contour of each cam. The angular position of the cams in Fig. 7 is the same as the angular position which they assume on their common shaft. It will be noted that the cams when in the position represented in Fig. 7 will hold all of the forming rolls in the raised position shown in Fig. 1 because a high point of each of the cams is adjacent the cam roller. After the cams have made one-sixth of a revolution in the direction of the arrows to bring sector II into the position occupied by sector I in Fig. 7, the cam rollers will be opposite low points of cams 13^2 and 13^5 thus permitting forming rolls 2 and 5 to lower as shown in Fig. 2, but high points of cams 13^1, 13^3, 13^4 and 13^6 will hold forming rolls 1, 3, 4 and 6 in their raised position. When the cams have rotated far enough to bring sector III into the position occupied by sector I in Fig. 7, high points of cams 13^2 and 13^5 will again raise the forming rolls 2 and 5 and high points on the remaining cams will keep all of the other forming rolls raised as shown in Fig. 3. When the cams have rotated far enough to bring sector IV in the position occupied by sector I in Fig. 7, low points on the cams 13^3 and 13^4 will permit forming rolls 3 and 4 to lower while high points on the other cams will keep the other rolls raised as shown in Fig. 4. Further rotation of the cams to bring sector V to the position occupied by sector I in Fig. 7 will cause low points on cams 13^2 and 13^5 to again lower the forming rolls 2 and 5 while low points on cams 13^3 and 13^4 permit rolls 3 and 4 to remain lowered and high points on cams 13^1 and 13^6 will keep forming rolls 1 and 6 raised as shown in Fig. 5. When the cams rotate further to bring sector VI in the position occupied by sector I in Fig. 7 low points on cams 13^1 and 13^6 will permit the forming rolls 1 and 6 to descend while low points on the cams 13^2, 13^3, 13^4, and 13^5 will permit the forming rolls 2, 3, 4 and 5 to remain lowered. All of the forming rolls are now in their lowered position as shown in Fig. 6. Further rotation of the cams brings sector I back to the position shown in Fig. 7 whereupon all of the forming rolls are raised to the initial position shown in Fig. 1.

The trimming mechanism for trimming the edges of the sheet which are parallel with the corrugations preferably comprises a pair of shafts 19 (Figs. 8 and 9) which extend transversely across the forming rolls, just above them, and are rigidly spaced apart to form a carriage. The ends of the shafts 19 carry rollers 20 which operate on the extreme forming rolls 1 and 6 so that the carriage can be moved back and forth longitudinally of the forming rolls, the rolls 1 and 6 serving as tracks for this purpose. On each end of the carriage is mounted an electric motor 21 which operates a cutting disc 22. The cutting disc cooperates with a bed plate 23 which is preferably elongated in the direction of movement of the carriage as best shown in Fig. 9. After the end corrugations have been formed in the sheet by the forming rolls 1 and 6, the trimming carriage, which is now at one end of its travel, is moved along its track formed by the rolls 1 and 6. During the first part of its movement the near corners of the corrugated sheet are lifted up to allow the forward ends of the bed plates 23 to pass under the edges of the sheet, whereupon further movement of the carriage will cause the bed plates to travel along under the edges of the sheet and the cutting discs 21 will trim the edges of the sheet in the manner shown in Fig. 8.

The edges of the sheet which lie at right angles to the corrugations are trimmed by the mechanism shown in Fig. 10. This mechanism may comprise a pair of standards 24 supporting a pair of horizontal shafts 25 on which there is adjustably mounted a pair of motors 26. Each of the motors operates a cutting disc 27. The shafts 25 are vertically adjustable on the standards 24. The track 7 on which the carriage C is mounted extends between the standards 24 as shown in Fig. 11, so that the carriage and the sheet supported by it may be made to travel between the standards in order that the edge portions of the sheet projecting beyond the edges of the platen may be trimmed by the cutting discs 27 as depicted in Fig. 10.

In operation the platen P is mounted on the carriage C and then the flat sheet, while still in a wet and plastic condition, is laid on top of the platen. The carriage is then first moved between the standards 24 of the trimming mechanism shown in Fig. 10. This will trim the edges of the sheet which are parallel with the direction of movement of the carriage and at right angles to the corrugations to be formed in the sheet. A further movement of the carriage will bring it under the forming mechanism shown at the left in Fig. 11. The carriage is properly positioned under the forming rolls so that when they descend they will move into the corrugations of the platen. The cam shafts are then actuated to cause the forming rolls to operate in the particular sequence hereinbefore described. After all of the corrugations have been formed in the sheet, and while the forming rolls are in the position shown in Fig. 6, the trimming carriage mounted on the extreme rolls 1 and 6 is moved longitudinally along these rolls, as hereinbefore described, to trim the edges of the sheet which are parallel with the corrugations in the sheet. If desired the carriage may first be positioned under the forming mechanism, the corrugations formed in the sheet and the edges of the sheet trimmed which are parallel with the corrugations, and then the carriage may be moved between the standards 24 to trim the edges of the sheet which are at right angles to the corrugations. In this case however the trimming knives 27 will have to cut to a greater depth because the sheet is corrugated and it is therefore preferred to trim these edges of the sheet as a preliminary operation before the sheet is corrugated. When this step is performed as a preliminary operation the cutting discs 27 need not be adjusted to cut to a depth as great as that shown in the drawings.

After the sheet has been corrugated and trimmed as above described the platen and the sheet are removed as a unit from the carriage. A number of platens with their still wet and plastic corrugated sheets may be nested and stacked until the sheets are dry and ready for removal from the platens.

I claim:

1. The method of corrugating plastic sheets which comprises first forming in the sheet a pair of corrugations extending the length of the sheet along spaced lines, one of which is located between the middle portion of the sheet and one edge thereof and the other of which is located between the middle portion of the sheet and the other edge thereof, thereafter forming in the middle portion of the sheet at least one corrugation extending the length of the sheet along a line located between the first formed corrugations, and thereafter forming a pair of corrugations in the edge portions of the sheet extending the length thereof along lines, each of which lies outward of one of said first formed corrugations.

2. The method of corrugating plastic sheets which comprises first simultaneously forming in the sheet a pair of corrugations extending the length of the sheet along spaced lines, one of which is located between the middle portion of the sheet and one edge thereof and the other of which is located between the middle portion of the sheet and the other edge thereof, thereafter simultaneously forming in the middle portion of the sheet a pair of corrugations extending the length of the sheet along lines located between the first formed corrugations, and thereafter simultaneously forming a pair of corrugations in the edge portions of the sheet extending the length thereof along lines, each of which lies outward of one of said first formed corrugations.

3. The method of forming in a plastic sheet a series of at least five corrugations which comprises first simultaneously forming in the sheet two parallel corrugations extending the length of the sheet and located at opposite sides of the middle portion of the sheet, thereafter forming in the sheet at least one corrugation at the middle portion of the sheet, said corrugation lying parallel to the first two corrugations and extending the length of the sheet, and thereafter simultaneously forming in the sheet a pair of corrugations parallel to those previously formed and extending the length of the sheet, each of the corrugation last formed lying outward of one of said first formed corrugations.

4. The method of forming in a plastic sheet a series of six parallel corrugations extending the length of the sheet which comprises first simultaneously forming in the sheet the two corrugations which are to lie between the two middle corrugations and the end corrugations, thereafter simultaneously forming in the sheet the two middle corrugations, and thereafter simultaneously forming in the sheet the two end corrugations.

5. The method of forming in a plastic sheet a series of six parallel corrugations extending the length of the sheet which comprises first simultaneously forming in the sheet the second and fifth corrugations of the series, thereafter simultaneously forming in the sheet the third and fourth corrugations of the series, and thereafter simultaneously forming in the sheet the first and sixth corrugations of the series.

6. The method of corrugating plastic sheets which comprises subjecting portions of the sheet to molding pressure to form in the sheet two parallel corrugations located at opposite sides of the middle portion of the sheet and extending the length thereof, releasing the molding pressure, thereafter subjecting the middle portion of the sheet to molding pressure to form at least one corrugation in said middle portion, said corrugation lying parallel to the first two and extending the length of the sheet, thereafter, while maintaining the molding pressure at the last formed corrugation or corrugations, reapplying the molding pressure at the first formed corrugations, and thereafter, while maintaining the molding pressure at all the previously formed corrugations, subjecting portions of the sheet to molding pressure to form in the sheet a pair of corrugations extending the length of the sheet and lying parallel to the corrugations previously formed, each of the corrugations last formed lying outward of one of said first formed corrugations.

7. The method of corrugating plastic sheets which comprises subjecting portions of the sheet to molding pressure to simultaneously form in the sheet two parallel corrugations located at opposite sides of the middle portion of the sheet, and extending the length thereof, releasing the molding pressure, thereafter subjecting the middle portion of the sheet to molding pressure to simultaneously form two corrugations in said middle portion, said corrugations lying parallel to those previously formed and extending the length of the sheet, thereafter, while maintaining the molding pressure at the last formed corrugations, reapplying the molding pressure at the first formed corrugations, and thereafter, while maintaining the molding pressure at all the previously formed corrugations, subjecting portions of the sheet to molding pressure to simultaneously form in the sheet a pair of corrugations extending the length of the sheet and lying parallel to those previously formed, each of the corrugations last formed lying outward of one of said first formed corrugations.

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