

Nov. 12, 1940.

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2,221,200

METHOD AND APPARATUS FOR FORMING ARTICLES FROM PAPER PULP

Filed May 11, 1937

4 Sheets-Sheet 1

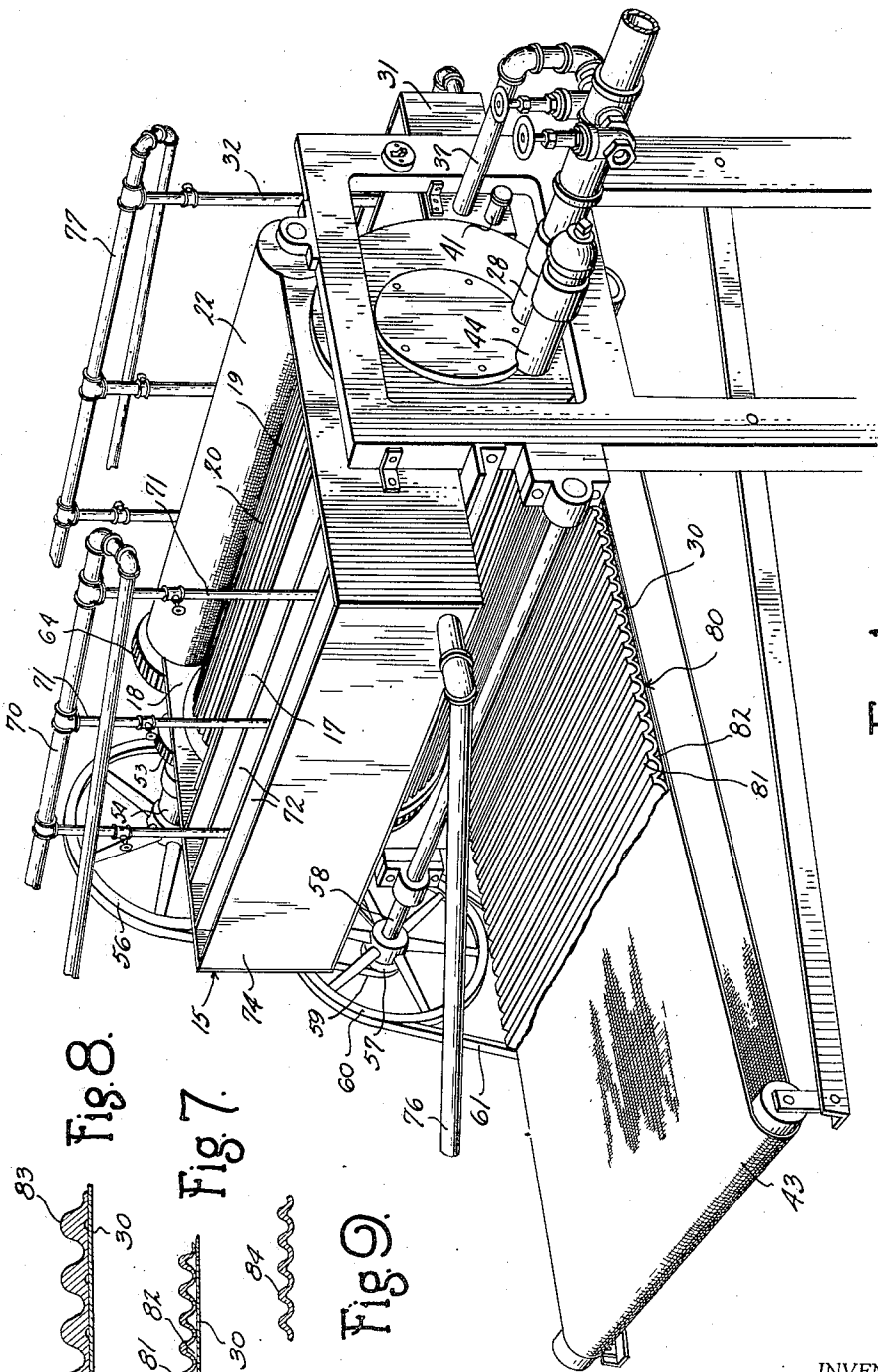


Fig. 1.

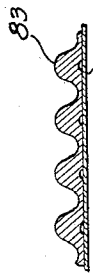


Fig. 8.

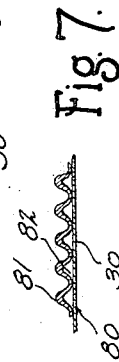


Fig. 7.

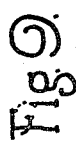


Fig. 9.

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4 Sheets-Sheet 2

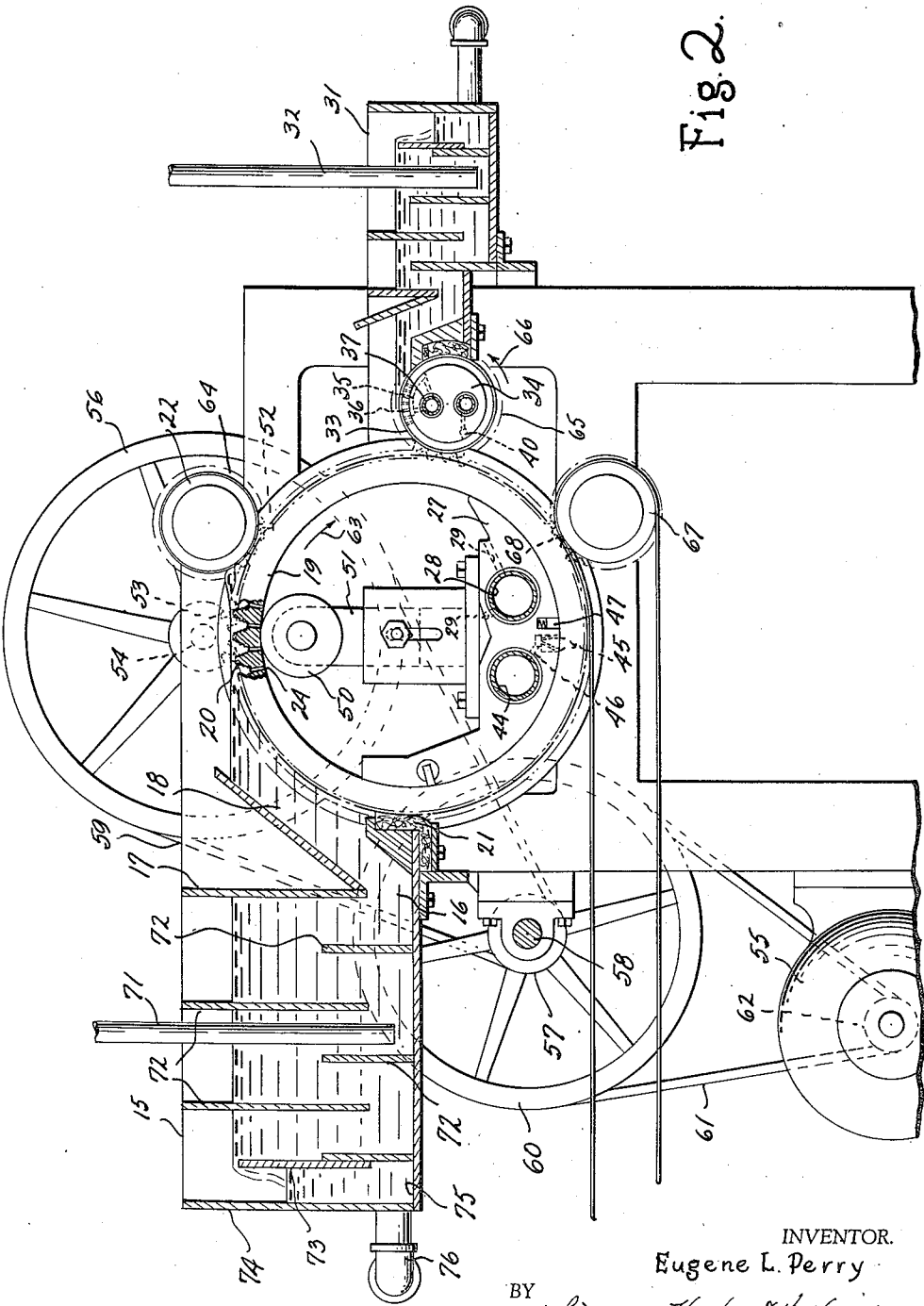


Fig. 2.

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4 Sheets-Sheet 3

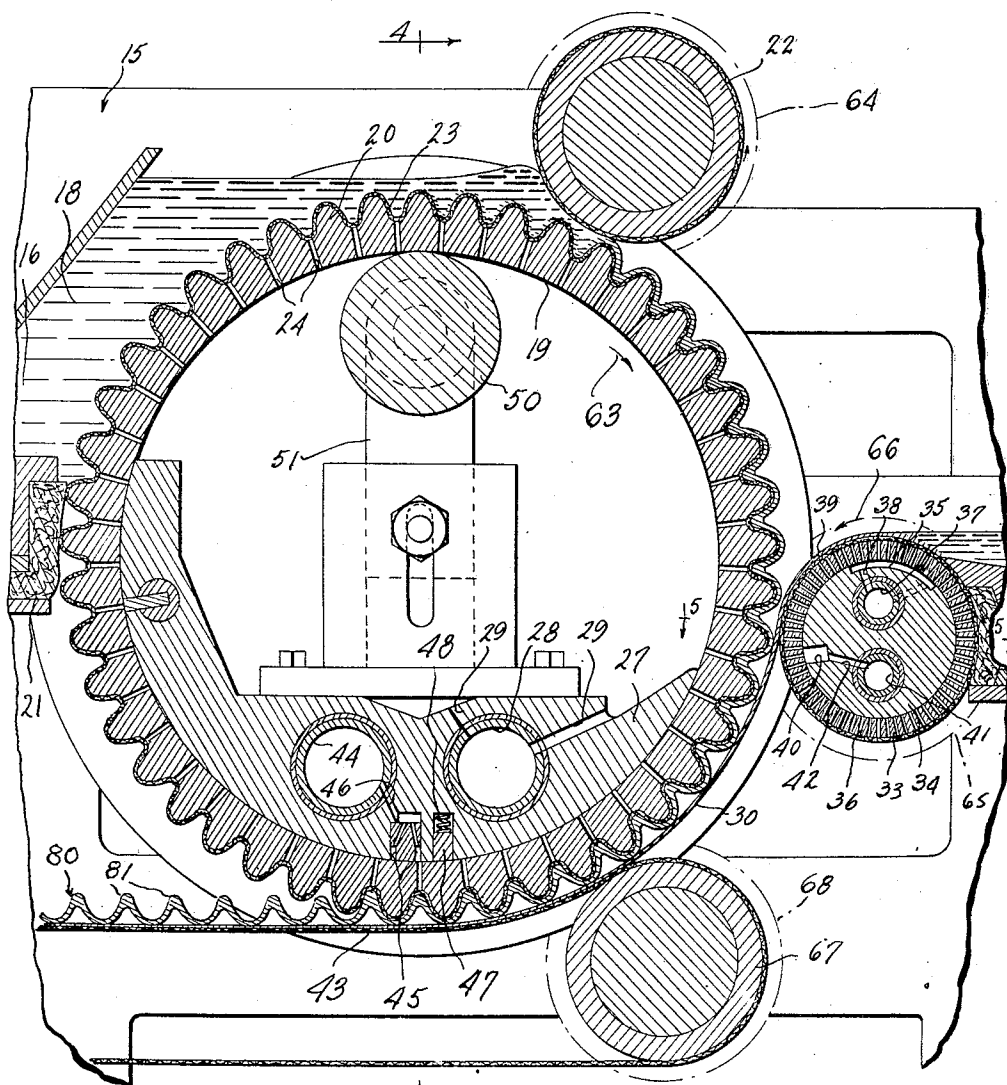
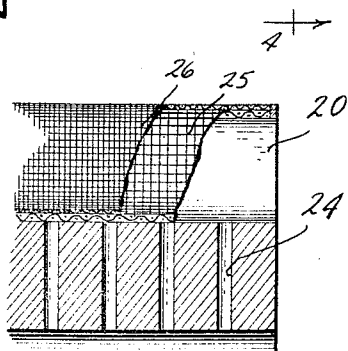


Fig. 3.

Fig. 6.

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4 Sheets-Sheet 4

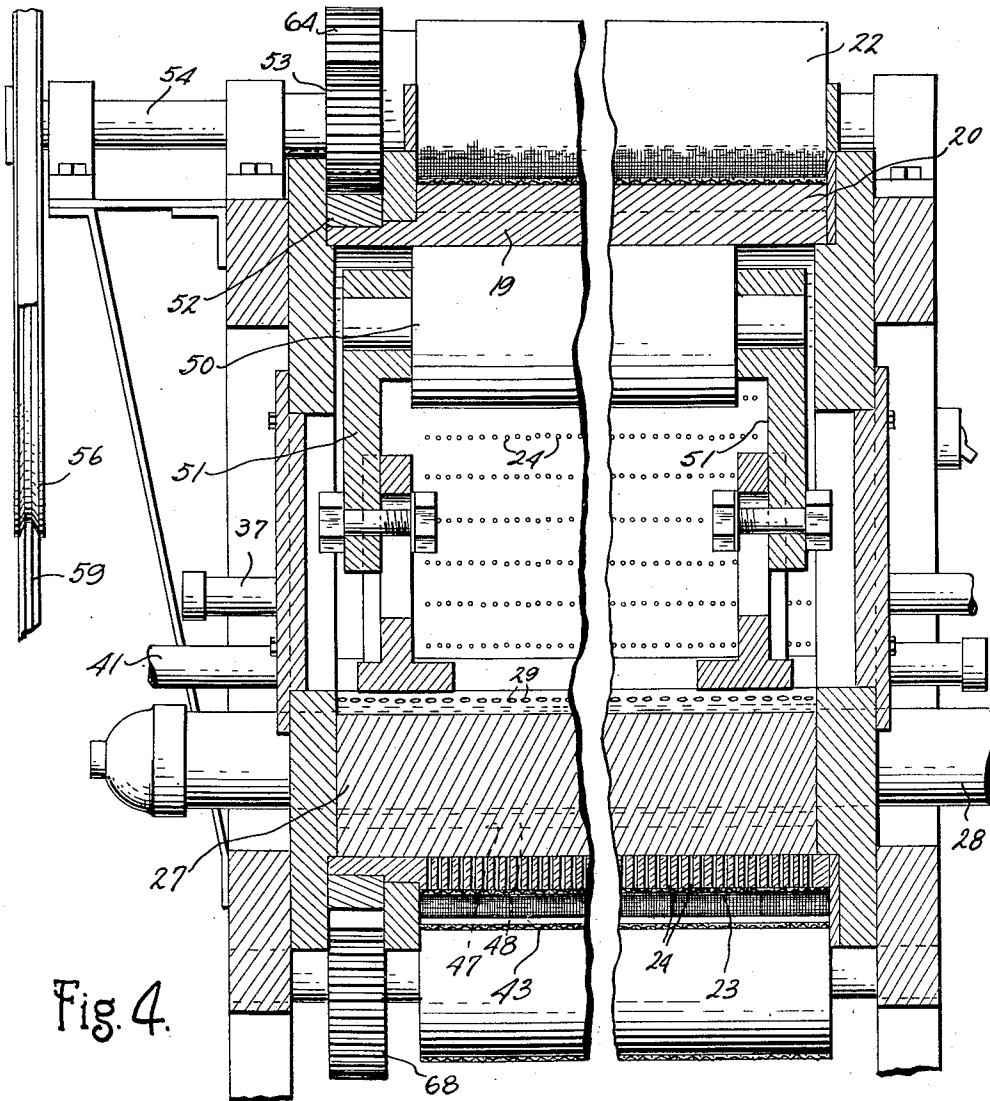


Fig. 4.

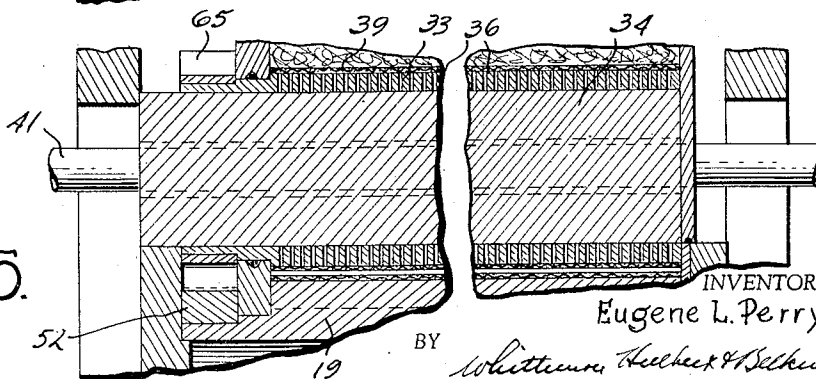


Fig. 5.

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UNITED STATES PATENT OFFICE

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METHOD AND APPARATUS FOR FORMING
ARTICLES FROM PAPER PULP

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6 Claims. (Cl. 92—39)

This invention relates generally to a method and apparatus for making sheets from a solution containing paper pulp and refers more particularly to the manufacture of corrugated sheets.

One of the principal objects of this invention consists in the provision of an improved method and apparatus for forming corrugated sheets with felted corrugations possessing some degree of resiliency and capable of being effectively employed as a protective wrapper or as a filler in shipping containers.

Another advantageous feature of the present invention resides in the provision of a method and apparatus rendering it possible to vary the cushioning qualities of the felted corrugations to suit the particular use of the material.

A further object of this invention is to provide a method and apparatus in which the corrugated sheet is successively formed and reinforced by applying a backing material to the sheet possessing sufficient inherent toughness to permit bending the sheet intermediate adjacent corrugations without cracking or separating the same.

In addition to the foregoing, the present invention contemplates forming the reinforcing sheet from paper pulp and conveying the sheet thus formed into contacting relation with the corrugated sheet adjacent the delivery end of the apparatus while both sheets possess sufficient moisture to cause the same to adhere together so that in effect the backing is molded on the corrugated sheet as the latter is discharged from the apparatus.

The foregoing, as well as other objects, will be made more apparent as this description proceeds, especially when considered in connection with the accompanying drawings, wherein:

Figure 1 is a perspective view of the apparatus employed in manufacturing the corrugated sheet;

Figure 2 is a semi-diagrammatic longitudinal sectional view of the apparatus shown in Figure 1;

Figure 3 is an enlarged view of a portion of Figure 2;

Figure 4 is a sectional view taken substantially on the plane indicated by the line 4—4 of Figure 3;

Figure 5 is a fragmentary sectional view taken substantially on the plane indicated by the line 5—5 of Figure 3;

Figure 6 is a fragmentary sectional view of one of the corrugations on the corrugated forming roll;

Figure 7 is a cross sectional view illustrating the product of my improved method and apparatus;

Figure 8 is a view showing a slightly modified form of product that may be manufactured by my improved method and apparatus; and

Figure 9 is a cross sectional view showing a further modification of the product capable of being formed by my improved method and apparatus.

The method of forming a corrugated sheet in accordance with this invention will perhaps be more fully understood upon considering the apparatus employed in carrying out the several steps of the method, although it is to be understood that the method is by no means limited to the particular apparatus selected herein for the purpose of illustration. In general, a tank 15 is supplied with a solution containing paper pulp and the percentage of the paper fibers suspended in the solution depends upon the particular grade of paper it is desired to form. Upon reference to Figure 2, it will be noted that the tank 15 is provided with a discharge opening 16 at the bottom of the inner side wall 17 thereof and this discharge opening communicates with a chamber 18 having one wall defined by the periphery of the drum 19. The drum 19 is shown in Figure 3 of the drawings as having the peripheral surface corrugated in such a manner that the corrugations 20 extend axially of the drum and are spaced from each other uniform distances circumferentially of the drum in accordance with the spacing of the corrugations desired on the product shown in Figure 7 of the drawings. Referring again to Figure 3, it will be noted that the corrugated periphery of the drum 19 forms the bottom wall of the chamber 18, and that the normal level of the suspension in the chamber 18 is maintained above the top side of the drum. The suspension is confined in the chamber 18 at one side by a seal 21 extending longitudinally of the drum in cooperation therewith and at the opposite side by means of a roll 22 extending for substantially the full length of the drum. The roll is supported with its periphery in close proximity to the periphery of the drum and revolves in a direction opposite the direction of rotation of the drum with the periphery thereof spaced from the adjacent surface of the drum to provide sufficient clearance for the passage of the fibers therebetween.

From the foregoing, it necessarily follows that the suspension in the chamber 18 will fill the

dwells or longitudinally extending recesses 23 between adjacent corrugations 20 of the drum as these recesses are moved throughout the angular space between the seal 21 and roll 22. Upon reference to Figure 3, it will be noted that each of the recesses 23 communicate with the interior of the drum through the medium of a series of radially extending passages 24 and a vacuum is effected within the drum for the purpose of withdrawing the moisture from the suspension in the chamber 18. In the present instance, the periphery of the drum is encircled by two screens identified in Figure 6 by the reference characters 25 and 26. Both of the screens conform exactly to the periphery of the drum and the inner screen, or the screen immediately adjacent the corrugated periphery of the drum, is of larger mesh than the outer screen 26. As a result, the fibers suspended in the solution are accumulated on the corrugated screening as the moisture is drawn into the drum by the vacuum. Inasmuch as the passages 24 through the drum communicate with the bottoms of the recesses 23 between adjacent corrugations 20, it follows that the pull effected by the vacuum is concentrated in this region of the recesses and that a larger number of the fibers will be accumulated on the screening in the bottom portions of the recesses. Due to the relatively large mesh screening 25, a certain amount of the vacuum pull will be transferred to the crest or outer edges of the corrugations 20 and, as a result, fibers will accumulate on the outer edges of the corrugations to a lesser extent than they accumulate in the recesses 23. It follows from the above that the thickness of the fibers in the recesses 23, which corresponds to the corrugations of the finished product shown in Figure 7, depends to a large extent upon the length of time that the suspension is subjected to the action of the vacuum and that this thickness may be controlled to produce either the product shown in Figure 7 or the one shown in Figure 8 by varying this time interval. In other words, if it is desired to produce the product shown in Figure 8 having practically solid corrugations, the speed of rotation of the drum may be reduced, or the position of the roll 22 may be changed to provide a greater angular travel of the drum through the suspension. It may be pointed out at this time that the roll 22 will also serve to level off the fibers accumulated on the corrugations of the drum as these corrugations are successively advanced past the roll.

Referring again to Figure 3 of the drawings, it will be noted that the vacuum pull on the corrugated sheet is continued after the drum advances the sheet beyond the roll 22, and this is for the purpose of withdrawing any excess moisture from the sheet. The vacuum is cut off at the underside of the drum by means of a fixed arcuate valve member 27 located in the drum and having an outer surface corresponding exactly to the inner cylindrical surface of the drum so as to have a sliding fit with this surface. The member 27 also supports the exhaust conduit 28 having one end communicating with a suitable vacuum pump (not shown) and having the opposite end communicating with the interior of the drum through the medium of passages 29. It will, of course, be understood that the moisture withdrawn from the product into the drum is conducted into the exhaust conduit 28 and is discharged from this conduit through the vacuum pump.

It has been mentioned above that the present invention contemplates applying a backing, or

reinforcing sheet, to the corrugated sheet in order to strengthen the latter. In the present instance, the backing sheet 30 is formed of a comparatively good grade of paper in order to possess the degree of toughness required to effectively reinforce the corrugated sheet and to permit bending of the corrugated sheet without cracking, or separating the same. Upon reference to Figure 2, it will be noted that a solution having the proper percentage of paper pulp suspended therein is pumped into a tank 31 from a supply line 32 and the level of this suspension is so determined with respect to a second vacuum drum 33 to permit the same to flow over the top of the drum. The second drum 33 is rotatably mounted on a cylinder 34 having an external diameter approximating the internal diameter of the drum and having an arcuate recess 35 in the periphery thereof at the upper side of the same for successively communicating with a series of circumferentially spaced passages 36 extending radially through the drum. The arcuate recess 33, in turn, communicates with a passage 37 through the medium of ports 38, and the passage 37 is connected to a suitable vacuum pump (not shown). The periphery of the drum 33 is encircled by a screen 39 of relatively fine mesh and this screen is secured in any suitable manner to the drum for rotation therewith as a unit. As a result of the above construction, the moisture in the paper pulp suspension is withdrawn through the radial passages 36 into the exhaust conduit 37 as the passages successively register with the arcuate recess 35 and the relatively fine fibers accumulate on the screen 39 to form the backing sheet 30.

Upon reference to Figure 3, it will be noted that the drum 33 extends for substantially the full length of the drum 19 and is supported in such close proximity to the periphery of the drum 19 that the backing sheet 30 contacts with the adjacent surface of the corrugated sheet advancing with the drum 19. Inasmuch as both the corrugated and backing sheet still retain a certain amount of moisture, it necessarily follows that the backing sheet will adhere to the adjacent surface of the corrugated sheet and will move with the latter in the direction of rotation of the drum 19 which, of course, is opposite to the rotation of the drum 33. In order to insure disengagement of the backing sheet 30 from the drum 33 and to adhere this backing sheet with the corrugated sheet on the drum 19, provision is made for forcibly moving the backing 30 against the corrugated sheet on the drum 19. This is accomplished in the present instance by forcing air under pressure through the radial passages 36 as the latter successively approach a position directly opposite the periphery of the drum 19. As shown in Figure 3, a longitudinally extending recess 40 is formed in the cylinder 34 on which the drum 33 is supported and this recess communicates with a fluid pressure supply line 41 through the medium of passages 42.

As a result of the foregoing operations, the corrugated sheet on the periphery of the drum 19 is provided with a relatively tough backing sheet 30 and as the corrugated sheet with its backing approaches the bottom side of the drum 19, it is deposited on a conveyor 43 of the flexible belt type. The corrugated sheet with its backing is ejected from the drum 19 by means of fluid under pressure and this is accomplished in the following manner. Referring again to Figure 3, it will be noted that a fluid pressure supply line 44 is supported in the arcuate valve member

27 and this line communicates with a pair of circumferentially spaced recesses 45 extending axially of the drum 19. The recesses 45 communicate with the supply line through the medium of passages 46 and successively communicate with the passages 24 through the drum in order to insure disengagement of the corrugated sheet with its backing from the drum 19. Any tendency for the fluid under pressure to escape into the vacuum portion of the drum is minimized by a sealing strip 47 mounted in the periphery of the arcuate valve member 27 and normally urged into frictional engagement with the inner cylindrical surface of the drum 19 by means of a spring 48.

From the brief description noted above, it follows that various different types of corrugated sheets may be readily and inexpensively formed. It will, of course, be understood that the provision of the backing sheet 30 is not necessary and this step in the method may be readily eliminated. It should also be understood that several laminations of the backing sheet 30 may be applied to the corrugated sheet by merely duplicating the drum units 33.

Referring now more in detail to the particular construction of the apparatus, it will be noted from the several figures of the drawings that the drum 19 is supported for rotation on an idler roll 50 engageable with the inner cylindrical surface of the drum at the upper side of the latter and mounted for vertical adjustment on brackets 51. The idler roll 50 is adjusted in such a manner that the inner cylindrical surface of the drum 19 frictionally engages the outer surface of the arcuate valve member 27 previously described as extending for a substantial distance circumferentially of the drum at the lower side thereof and as having a length approximating the length of the drum. Upon reference to Figures 2 and 4, it will be noted that a ring gear 52 is secured to one end of the drum and this ring gear meshes with a pinion 53 secured to the driven shaft 54, which in turn is operatively connected to the prime mover 55 shown in Figure 2. The operative connection between the shaft 54 and the prime mover is of the reduction type and comprises a series of pulleys interconnected through the medium of belts. In detail, a pulley 56 of relatively large diameter is secured to the shaft 54 and is connected to a relatively small diameter pulley 57 on the idler shaft 58 by means of a belt 59. The idler shaft 58 also has a relatively large diameter pulley 60 secured thereto and this pulley is connected by means of a belt 61 to a small diameter pulley 62 secured to the drive shaft of the motor 55. In the above manner, the drum is revolved at a reduced speed from the motor in the direction of the arrow 63 in Figure 3.

The roll 22 is rotated in the opposite direction by means of a pinion 64 secured to one end of the roll and meshing with the ring gear 52. Also, the ring gear 52 drives the drum 33 in the opposite direction by a pinion 65 secured to the drum 33 and directly meshing with the ring gear. This arrangement provides for rotation of the drum 33 in the direction of the arrow 66 shown in Figure 3 and causes the backing 30 to advance in the same direction as the corrugated sheet on the drum 19. In addition, the conveyor 43 is driven from the ring gear 52 on the drum by means of a roll 67 having a pinion 68 therein meshing with the ring gear 52.

As hereinbefore stated, the paper pulp suspen-

sion is supplied over the drum 19 from the tank 15 and this tank is supplied with the proper suspension from a pressure supply line 70 communicating at spaced points with the interior of the tank by means of a plurality of valve controlled discharge conduits 71. Upon reference to Figure 2, it will be noted that the tank is provided with a series of baffles 72 predeterminedly arranged on opposite sides of the discharge conduit 71 to minimize the turbulence of the suspension caused by discharging the latter into the tank. The level of the suspension in the tank is controlled so that this suspension extends over the top of the drum and this is effected in the present instance by predeterminedly the height of the outermost baffle 73. In other words, the baffle 73 co-operates with the outer wall 74 of the tank to form a compartment 75 and the lower end of this compartment communicates with a drain conduit 76 which in turn communicates with the reservoir or source of supply for the suspension. As a consequence, as soon as the level of the suspension exceeds the height of the baffle 73, this suspension will enter the compartment 75 and be directed back to the source of supply through the conduit 76.

The tank 31 supplying the drum 33 with pulp suspension is similar in construction to the tank 15 but in the present instance communicates with a separate supply line 77. This is desirable in that the reinforcing backing sheet 30 is preferably of a finer grade of paper than the corrugated sheet formed on the drum 19 and, therefore, the percentage of pulp in the suspension supplied to the tank 31 varies accordingly. Of course, it will be understood that if the backing is formed of the same grade as the corrugated sheet, the tank 31 may be supplied with suspension from the same source as the tank 15.

The product formed in accordance with the method and apparatus previously described is shown in Figure 7. As will be observed from this figure, the product 80 comprises a corrugated sheet and a backing sheet. The corrugations 81 are felted in the manner described above to impart a cushioning quality to the product which, in the present instance, is enhanced by controlling the felting to such an extent that a longitudinally extending recess 82 is formed in the underside of each corrugation. In Figure 8, a corrugated product is disclosed formed in accordance with the present method and apparatus, but differing from the product shown in Figure 7 in that the corrugations are felted to a greater degree. In other words, the corrugations 83 are practically solid and this is accomplished by subjecting the material to the action of the vacuum for a greater period of time. In Figure 9, a product is shown wherein the backing sheet 30 is omitted from the corrugated sheet 84 and this is accomplished by merely eliminating the drum 33 and its associated parts.

What I claim as my invention is:

1. In apparatus for forming a corrugated sheet from a material containing paper pulp, a revoluble drum having a corrugated peripheral surface and having restricted passages therethrough at the bottom portions of the recesses between the corrugations, means for conducting a solution containing paper pulp over a portion of the corrugated surface of the drum, means creating a vacuum in the drum for withdrawing moisture from the suspension in the bottom portions of the recesses through said passages and depositing a relatively thick layer of fibers there-

in, and a corrugated mesh screen positioned adjacent the corrugated surface of the drum for transferring a diminished amount of the vacuum to the regions of the corrugated surfaces of the drum at opposite sides of the passages to deposit a relatively thin layer of fibers thereon.

2. In apparatus for forming a corrugated sheet from a material containing paper pulp, a revoluble drum having a corrugated peripheral surface and having restricted passages there-through at the bottom portions of the recesses between the corrugations, means for conducting a solution containing paper pulp over a portion of the corrugated surface of the drum, means creating a vacuum in the drum for drawing moisture in the suspension into the drum through said passages, a corrugated comparatively fine mesh screen corresponding in contour to the corrugated surface of the drum for collecting the fibers, and a corrugated comparatively wide mesh screen interposed between the fine mesh screen and the corrugated surface of the drum to transfer a proportionately diminishing amount of the vacuum to the regions of the corrugated fine mesh screen at opposite sides of the passages to deposit a layer of fibers on said fine mesh screen proportionately diminishing in thickness from the bottom portions of said recesses to the crests of said corrugations.

3. In apparatus for forming a corrugated sheet from a material containing paper pulp, a revoluble drum having a corrugated peripheral surface, means for conducting a solution containing paper pulp over a portion of the corrugated surface of the drum, means for drawing moisture from the suspension through the drum causing the fibers to deposit on the corrugated surface of the drum to form a felted corrugated sheet having alternate ridges and recesses, and means spaced in the direction of rotation of the drum from the region of the latter subjected to the paper pulp suspension for making a thin backing sheet from paper pulp and operable to advance the backing sheet in the direction of rotation of the drum to cause the backing sheet to contact the ridges of the felted corrugated sheet and to adhere thereto by virtue of the moisture remaining in the sheets.

4. In apparatus for forming a corrugated sheet from a material containing paper pulp, a revoluble drum having a corrugated peripheral surface, means for conducting a solution containing paper pulp over a portion of the corrugated surface of the drum, means for drawing moisture from the suspension through the drum causing the fibers to deposit on the corrugated surface of the drum to form a felted corrugated sheet having alternate ridges and recesses, means spaced in the direction of rotation of the drum from the region of the drum subjected to the suspension for advancing a sheet of thin backing

material in the direction of advancement of the corrugated sheet by the drum, and means for applying a pressure against the backing sheet in a direction toward the drum to cause the backing sheet to adhere to the ridges of the felted corrugated sheet.

5. In apparatus for forming a corrugated sheet from a material containing paper pulp, a revoluble drum having a corrugated peripheral surface, means for conducting a solution containing paper pulp over a portion of the corrugated surface of the drum, means for drawing moisture from the suspension through the drum causing the fibers to deposit on the corrugated surface of the drum to form a felted corrugated sheet having alternate longitudinally extending ridges and recesses, a second revoluble drum adjacent the first drum and spaced in the direction of rotation of the first drum from the region of the latter subjected to the paper pulp suspension, means for conducting a solution containing paper pulp over a portion of the peripheral surface of the second drum, means for drawing moisture from the suspension through the second drum causing the fibers to deposit thereon to form a thin felted backing sheet, means for rotating the second drum in a direction opposite to the direction of rotation of the first drum to advance the backing sheet in the direction of rotation of the first drum in close proximity to the periphery of the latter, and means for applying a pressure against the backing sheet in a direction toward the first drum to cause the backing sheet to adhere to the longitudinally extending ridges of the felted corrugated sheet by virtue of the moisture remaining in the sheets.

6. Those steps in the method of forming a corrugated sheet which consist in covering a portion of a drum having alternate longitudinally extending ridges and recesses with a solution containing paper fiber, subjecting the suspension in the recesses to a vacuum to withdraw moisture from the suspension through the drum to deposit a layer of fibers in the recesses, subjecting the suspension adjacent the ridges to a vacuum less than the vacuum aforesaid to deposit a thinner layer of fibers thereon, covering a portion of the surface of a second drum with a solution containing paper fiber, subjecting the suspension adjacent the second drum to a vacuum to withdraw moisture from the suspension and deposit a thin layer of fibers thereon to form a backing sheet, advancing the backing sheet in the same direction as the corrugated sheet and in contact therewith, and applying a pressure to the backing sheet in a direction toward the corrugated sheet while both are sufficiently damp to cause the backing sheet to adhere to the longitudinally extending ridges of the corrugated sheet.

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