Dec. 7, 1926. 1,609,318

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METHOD AND MECHANISM FOR PRODUCING CORRUGATED MATERIALS

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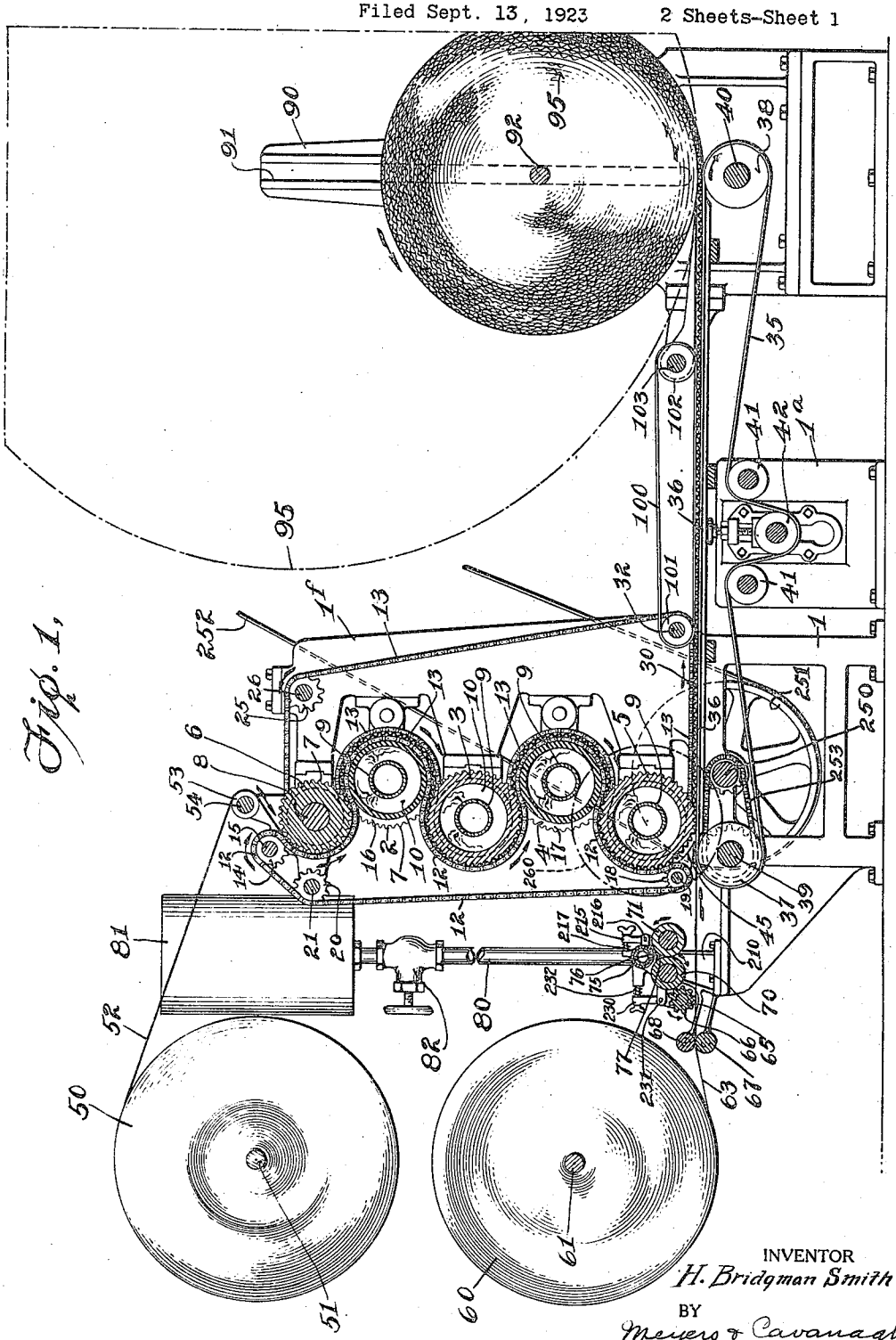


Fig. 1.

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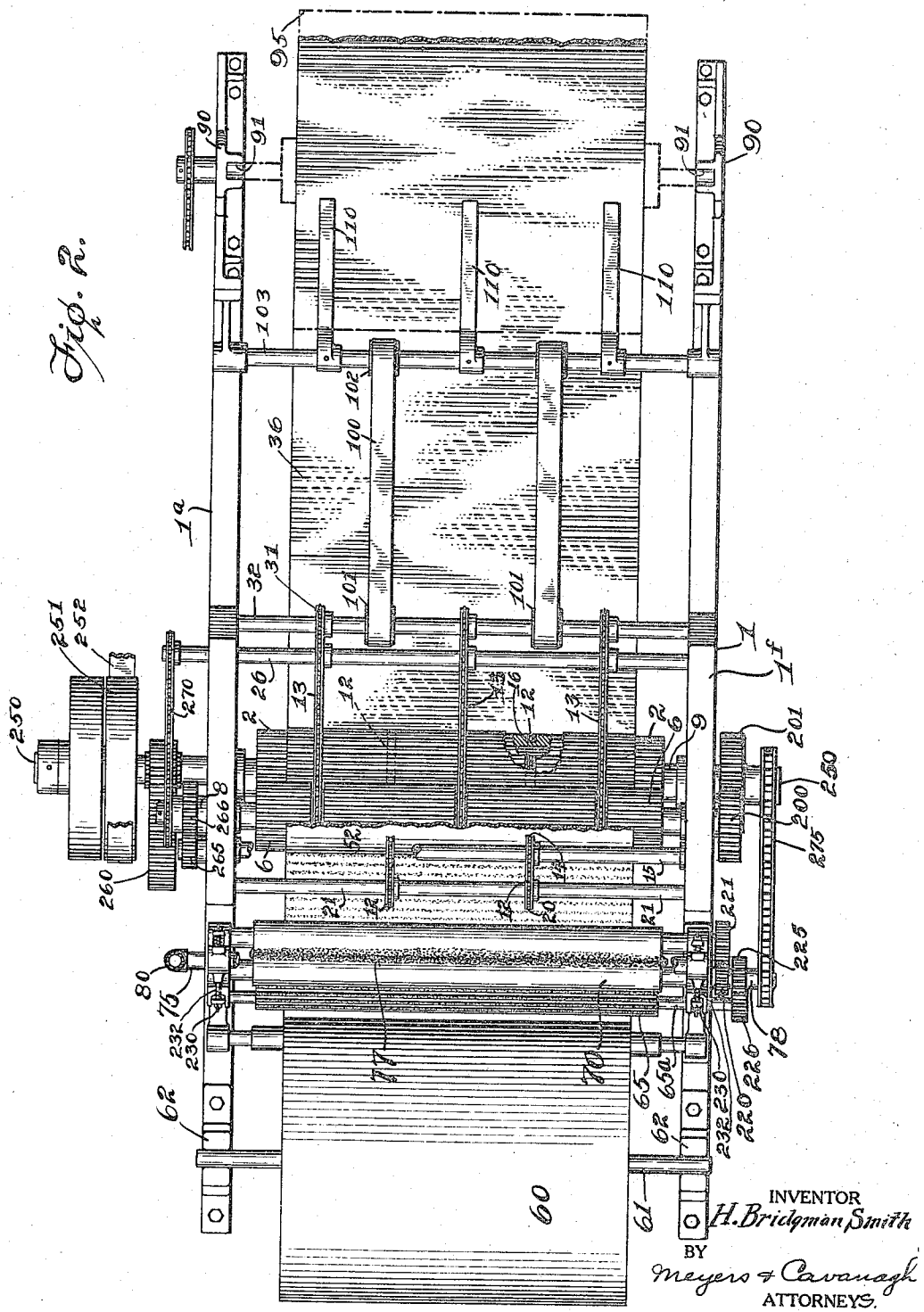
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Fig. 2.



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UNITED STATES PATENT OFFICE.

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METHOD AND MECHANISM FOR PRODUCING CORRUGATED MATERIALS.

Application filed September 13, 1923. Serial No. 662,485.

My invention relates to the art of producing corrugated sheet material such as corrugated paper or pasteboard, with or without a facing, including production methods and machines operating in accordance with the methods.

The general object of the invention is to simplify and improve mechanism and methods which have heretofore been used for producing corrugated sheet material, and particularly to eliminate difficulties heretofore encountered in "threading", or passing the free end of the web through the corrugating devices at the beginning of operations or whenever the web is broken or a new roll has to be inserted; to produce transverse corrugations of desired form and depth and to maintain the corrugations in the desired form while the web is subjected to a plurality of pressing operations and also while it is carried through a relatively long course in contact with corrugating cylinders, and, desirably, while it is carried still farther under such satisfactory control that the corrugations are not permitted to lose their shape, to a point where the completed material is properly disposed of; to properly direct the web from one corrugating roll to another and to a plurality of pressing points between different rolls while maintaining the web in close contact with the corrugations of the successive rolls and preferably to maintain this contact throughout a large part or more than half of each roll circumferences; and to effectively and properly strip the corrugated web from each corrugating roll, this stripping operation with respect to all except the last roll of the series usually being concurrent with the application to and guidance of the web about the next successive roll in the series.

A further object is to provide an improved method and means for applying a facing sheet to the corrugated web in such a way that there is no tendency for the ribs of the corrugated sheet to become deformed prior to, during, or after application of the facing sheet, and to apply the necessary adhesive for securing the facing web in a new and improved manner.

A still further object is to provide a new and improved method and means for winding the completed web of corrugated material in rolls.

In accordance with methods and mechanisms heretofore suggested and used for producing transversely corrugated webs of sheet material, such as cardboard, the corrugations have usually been produced either by cooperating members of articulated traveling belts, the corrugations being produced by interfitting members of the belts and the web being carried through a fairly long course between parallel stretches of the belts; or the corrugations have been produced by ribbed rollers. In the first case the articulated belts or like devices are unduly complicated and expensive, and more or less uncertain and slow in operation, it is also relatively difficult to properly heat the pressing elements, and other objections and difficulties are also involved, as sufficiently understood by persons familiar with these mechanisms. In the second case, owing to failure to provide suitable web-guiding, stripping and controlling devices, it has been found difficult and practically impossible to convey the web through a sufficiently long course in contact with corrugating roll surfaces to produce the desired corrugated formation; and in fact in practical machines known to me the number of corrugating rolls acting on any web of material to be corrugated is not greater than three, and the web actually passes about portions of no more than two of the rolls. In other machines proposed and used, the web passes around a portion of only a single roll and is subject to corrugating pressure between only one pair of cooperating rolls. These constructions or arrangements are largely due to the use of fixed guide or guard plates partly or entirely overlying the web surfaces as they pass about the corrugating rolls, and the employment of fixed strippers, and the difficulty experienced in "threading" the web between the rolls and the guides and strippers, this difficulty increasing with the number of rolls, which is therefore practically limited as above stated, in spite of the

fact that it is difficult or impossible to produce permanent corrugations of proper form on a rapid production basis with so few rolls or points of roll-contact. Travelling strippers or stripper belts have been suggested, but such belts or equivalent devices so far as I am aware have only been used to strip the web from a single roll or to direct it from a single point of roll contact, and not to guide the web around any corrugating roll or to guide and properly retain it in contact with corrugating surfaces in a circuitous course about a plurality of corrugating rolls, or to divert it from one roll to another while maintaining the proper corrugated formation.

In certain corrugating machines in which a facing sheet is applied to the corrugated web, the latter is permitted to travel freely after it leaves the corrugating rolls and before the facing is applied, and during this free travel the corrugations stretch more or less in the longitudinal direction of the web and thus become shallow, or in other ways lose their proper form. It is customary in certain machines to apply glue, for securing the facing web, to the crests of the ribs of the corrugated web. This involves certain difficulties, including the necessity for exposing one face of the corrugated web to the glue applying device and consequently losing proper control of the web at that point. In other machines glue is applied to the facing web; but in these cases, so far as I am aware, glue is applied all over the facing, with the corresponding unnecessary increase in cost of adhesive, since in most cases the coating on the parts of the facing sheet intermediate the ribs of the corrugated web, is superfluous.

Difficulty has also been experienced in machines of this class in winding the completed web of corrugated material in roll form, due to the fact that the completed roll has usually been driven from its center or from the shaft on which it was wound, and this involves a friction drive or other variable-speed drive, with accompanying complications and difficulties, because of the constantly varying diameter of the roll and the consequent necessity for driving it at constantly varying surface speeds.

To avoid the above mentioned and other difficulties and disadvantages of existing structures and methods, and to realize the above stated and other objects, my invention, as briefly described, provides for passing a web of suitable sheet material such as cardboard, around a plurality of corrugating rolls and usually around large peripheral portions of three or more rolls, subjecting the web to corrugating pressure between adjacent rolls at a plurality of points and preferably at three or more points, and effectively directing, guiding and retaining the web in proper contact with the corrugated surfaces, positively maintaining its corrugated formation throughout its course of travel by continuous traveling bands or belts which not only guide and retain the web in the stated manner but also act as traveling strippers and guides to strip the web from each roll and deliver or apply it to the next one while maintaining the corrugated formation and proper contact with the roll surfaces; and the traveling belts or bands are further desirably arranged to strip the web from the final corrugating roll and maintain the corrugated formation during a further course of travel to a point of utilization or disposal, such as the point where the corrugated web is wound in roll form.

The invention also provides, in cases where a facing sheet is desired, for advancing a strip of suitable facing material, usually paper, from a roll and applying it to the corrugated web while the latter is still under positive control to maintain its proper corrugated formation, and preferably applying the facing strip to the corrugated web before the latter leaves the last corrugating roll, and maintaining the web and facing strip in contact between traveling guides or controlling devices through a course of substantial length and thus maintaining the proper ribbed formation of the corrugated web until adhesive applied to secure the facing strip can properly set and permanently secure the corrugations; and thereupon the faced web may be disposed of by cutting it into lengths, or rolling it, or otherwise.

The invention further provides for applying adhesive to a surface of the facing strip rather than to the crests of the ribs of the corrugated web. The adhesive may be applied all over a surface of the facing strip, or otherwise, and preferably in many cases, it is applied in the form of transverse stripes or bands corresponding to the location of rib-crests of the corrugated web when the two webs come in contact. In this way the advantage of applying the adhesive to the facing strip instead of the corrugated web is obtained, and at the same time the waste of adhesive involved in all-over coating of the facing strip is avoided, in any case where it is not necessary or desirable to completely coat the facing strip.

The invention further provides for winding the completed web, either of faced or unfaced corrugated material, by traction applied to the periphery of the roll, rather than by driving the roll from its center or the shaft upon which it is being formed.

The characteristics and advantages of the invention are further sufficiently explained in connection with the following detail description of the accompanying drawings, which show one exemplifying mechanism embody-

ing the invention and also sufficiently explain one performance of the process. After considering this example, persons skilled in the art will understand that many variations may be made within the principles of the invention, and I contemplate the employment of any structures and methods that are properly within the scope of the appended claims.

Figure 1 is a vertical, longitudinal section of essential parts of mechanism embodying the invention in one form.

Figure 2 is a top plan of the same, with certain parts omitted or broken away for the sake of clearness.

The frame of the machine is represented in somewhat diagrammatic fashion, for the sake of illustrative clearness. It includes side frame members 1, 1ª etc., which may be connected by any suitable transverse members. A plurality of corrugating rolls are rotatively supported in frame uprights 1ᶠ. The number of rolls may vary, and a large number of rolls may be employed when desired, because of the nature of the web-guiding devices employed. In the present instance, there are four main corrugating rolls 2, 3, 4 and 5, and preferably a primary corrugating roll 6 is provided to cooperate with the first main roll 2. All of the rolls have longitudinal ribs 7, the ribs of adjacent rolls being arranged to interfit, and being formed in cross section to produce the desired rib formation in the corrugated web. Primary roll 6 is supported by a shaft 8 which runs in suitable bearings in the frame, and rolls 2, 3, 4, and 5 are desirably hollow, and supported on tubular shafts 9 for the convenient supply of gas for heating the roll surfaces by combustion in the chambers 10 formed between the hollow shafts and the roll shells. The rolls are usually positively driven by suitable gear connections, such as gears 200, 201.

To secure a longer course of web travel in contact with the rolls, the roll axes are desirably offset alternately, as clearly shown in Figure 1. The roll axes are thus arranged in two parallel vertical planes, but evidently the rolls may be arranged in different positions or relations.

To properly guide and retain a web in its course between and around the rolls, suitable guide bands or belts are provided, and while the nature of these belts may vary considerably, in a preferred case, as shown, they are in the form of sprocket chains, which have ample flexibility with relative non-elasticity or freedom from stretching, and are well adapted to positively guide and hold the web in the desired fashion. One or more, usually a plurality of such chains 12 are arranged to engage and direct one side of the web and one or more, usually a plurality of similar chains 13 are provided to guide and direct the other side of the web. In the present specific case, there are two of the chains 12 and three of the chains 13, the chains at opposite sides of the web being evenly interspaced. Chains 12 run over sprockets 14 on a shaft 15, which may be positively driven. From sprockets 14 the chains pass about the crests of the ribs on roll 6 to a point where these ribs cooperate with the ribs of roll 2. The chains then enter annular channels 16 in roll 2, the depth of these channels being such that the outer surfaces of the chains are substantially flush with the bottoms of the rib-grooves of the roll. The chains then pass around the crests of the ribs of roll 3 and through grooves 17 in roll 4, which are arranged in the same fashion as grooves 16 previously mentioned, and then the chains pass around the crests of the ribs of roll 5 and about idler sprockets 18 on a shaft 19, and from that point upward and over idler sprockets 20 on a shaft 21 and then again around sprockets 14, and so on.

Desirably, a belt 35, which may be the full width of the web, (or else a plurality of spaced narrower belts), of any suitable material, such as canvas, is arranged with its upper stretch 36 parallel to the straight chain stretches 30 and spaced therefrom a distance equal to the thickness of the corrugated web. This belt or belts as the case may be, pass over forward and rear pulleys 37 and 38 on shafts 39 and 40 and may be suitably tensioned by any suitable device, such as pulleys 41 and intermediate adjustable pulley 42.

Sprockets 18 are arranged as close as convenient to forward pulleys 37, to bring the adjacent portions of the guide chains 12 as close as possible to the upper stretch of the belt where it comes under roll 5. Since a slight gap is practically unavoidable at this point, fixed guide fingers or blades 45 are provided, which may be supported on shaft 19 and which are contoured to fit close to the peripheries of the ribs of roll 5, and these guide fingers preferably are tapered off nearly to a point, so that they direct and hold the corrugated web in contact with the ribs of roll 5 almost up to the point where the upper stretch 36 of the belt strikes the web and holds it as it moves onward.

A roll 50 of paper or cardboard suitable for corrugating is supported by means of a shaft 51 which may rest in any suitable bearings on an upward part of the frame (not shown), and a web 52 is drawn from the roll and conducted in any suitable way to the initial corrugating roll; for instance, as shown, the web may be drawn over a guide roll 53 on shaft 54. The end of the web is then inserted between chains 12 and roll 6, and is carried around and held by the chains in firm contact with the crests of the

roll corrugations. The advancing end of the web then encounters the corrugations 7 on roll 2 and as the web advances between the rolls 6 and 2 it is properly pressed in ribbed forms by the interfitting corrugations, and as soon as each portion of the web passes the corrugating point the web is stripped away from roll 6 by chains 13, which emerge from the channels of roll 6 and pass about the periphery of roll 2 superposed upon the corrugated web and holding the latter firmly in contact with the corrugations of roll 2 throughout the larger part of its periphery. The web is then subjected to further corrugating pressure by the interfitting ribs of rolls 2 and 3, and is stripped away from roll 2 by chains 12 and is by them held properly upon roll 3, is again pressed between rolls 3 and 4 and stripped from roll 3 by chains 13 and guided about the periphery of roll 4, again pressed between rolls 4 and 5, stripped from roll 4 by chains 12 and guided about almost one-half the circumference of roll 5 by chains 12, and is then guided a short distance beyond the point where chains 12 are carried away from the roll, by the fixed guide fingers 45. The corrugated web is again engaged before it passes away from roll 5 by the upper stretch of belt 36, which, with chains 12 and guide fingers 45, serves to maintain the web in proper engagement with the corrugations of roll 5 throughout more than one-half of the roll circumference.

The web then proceeds away from roll 5, being stripped from the roll by chains 13, and is held between chain stretches 30 and the upper stretch 36 of belt 35 with sufficient firmness to prevent any, or any appreciable, elongation or loss of form of the corrugations.

It is thus evident that the described arrangement of parts and method of handling the web provides not only for conveying the web through a long course of travel past several points of corrugating pressure and in contact throughout its course with corrugating ribs, so that corrugations are properly formed and "set" practically permanently in the desired shape, and also, when desired, with ample heat treatment from the hot surfaces of the successive rolls, but the web is easily threaded through the rolls by action of the rolls and guides themselves without any annoyance or delay, the web feeding or guiding devices being all traveling devices which infallibly carry the advance edge of the web through the proper course when the edge is properly introduced between chains 12 and roll 6 without particular care or attention of the operator. The only fixed guide devices in the mechanism as so far described are the stationary blades 45, but these are arranged in the direction of web movement and offer no possible interference to passage of the web, either in the original "threading" or in subsequent operations.

While the corrugated web, produced as above described, may be conducted onward to any desired point of utilization without a facing, or may be faced in any usual way, it is usually preferred, in accordance with the invention, to apply a facing strip to the web while it is still controlled, or held in proper corrugated form. For this purpose a roll 60 of suitable facing paper is rotatably supported on a shaft 61 which rests in bearing sockets 62 on the frame, as sufficiently shown in Figure 2. The facing web 63 is drawn from the roll and is conducted over the upper stretch of belt 35 and under the guide blades 45 and into contact with a face of the corrugated web while the latter is still on roll 5 and firmly held thereon by belt 35, which in this case also serves to bring the facing strip in firm contact with the corrugated web, and to maintain it in such contact in the further travel of the webs between belt stretch 36 and chain stretches 30.

In producing faced corrugated board, it has been customary to apply adhesive to the crests of the corrugations and then bring the facing strip in contact with these glued corrugations; or, in some cases, the facing web has been coated all over before applying it to the corrugated web. The present invention provides improved means for applying the adhesive to the facing web, and also provides as a preferred arrangement for applying the adhesive thereto only in transverse strips or stripes corresponding to the subsequent location of crests on the ribs of the corrugated web when the latter is brought in contact with the facing web. For this purpose suitable adhesive-applying mechanism is provided at a point intermediate roll 60 and corrugating roll 5, consisting in the present example of the following: A glue-applying roll 65 carried by a shaft 65^a in suitable bearings, is provided with spaced longitudinal ribs 66, the spacing of these ribs corresponding to the crests of the ribs of the corrugated web. Glue is applied in any known or suitable way to the crests of ribs 66, and roll 65 is rotated, usually by positive driving means, in contact with web 63, which may be directed to the glue applying roll by guide rolls 67 and 68. The speed of travel of web 63 is, of course, equal to that of the completed corrugated web, since it is drawn along with the corrugated web by any suitable means (sufficiently described hereafter); and the corrugated periphery of roll 65 is driven at the same surface speed, which is also the surface speed of corrugating roll 5. Roll 65 is adjusted so that the glue stripes thus imprinted on web 63 are posi-

tioned in accordance with the positions of downwardly presented crests of the ribs on the corrugated web at the point of web-contact; and thereafter the relative position of roll 65 is maintained and the glue stripes are properly imprinted on the facing web which therefore adheres to the crest of every corrugation on the corrugated web 52.

Preferably improved means are provided for supplying glue to the crests of ribs 66, consisting in the present instance of the following: Cooperating glue-supply rolls 70 and 71 are provided, the surface of one of these rolls being of suitable elastic or compressible material, such as rubber or rubber composition, and preferably the surfaces of both of the rolls are composed of such material. The rolls are mounted in bearings in frame brackets 210. Desirably the rolls are brought together with yielding pressure, and for this purpose one of the rolls 71 is mounted on bearings on arms 215 pivoted at 216, and springs 217 act on the upper ends of the arms to urge the roll yieldingly against roll 70. Desirably, rolls 70 and 71 are so driven that engaging faces travel downward, and while they may be driven at the same speed, preferably one is driven faster than the other. Shaft 78 of roll 70 may be the primary driving member of the glue mechanism. A pinion 220 on shaft 78 engages a gear 221 on the shaft of roll 71, and gear 221 in this instance is made larger than gear 220 so that roll 71 travels slower than roll 70. With the described drive arrangement for the glue supply rolls, the glue applying roll 65 is conveniently driven from shaft 78 by gear 225 engaging a gear 226 on the glue roll shaft 65^a. This shaft is mounted in bearings in arms 230 pivoted at 231, and springs 232 act on the upper ends of the arms to hold the ribs of roll 65 yieldingly against the surface of glue supply roll 70. The teeth of the gears are so designed as to permit the slight degree of relative movement of the rolls.

The adjacent faces of the glue-supply rolls 70 and 71 above their line of contact provide in effect a trough to which suitable adhesive is applied in any suitable way, for instance, by a pipe 75, which runs along above the trough and has suitable apertures 76 to supply small streams of glue at intervals to form a long pool or body 77 of glue lying in the trough between the roll surfaces. Glue may be supplied to pipe 75 at one end by an upright pipe 80 leading from the glue tank 81 in which glue may be kept in proper condition in any known or suitable way; and the flow of glue may be controlled by any suitable valve 82.

The rotation of the supply rolls 70 and 71 in contact with the glue puddle in the trough formed by the roll surfaces, keeps the glue in proper condition and evenly distributes it over the surface of roll 70 in proper quantity or thickness; and the proper distribution and regulation of the thickness of the film of glue on roll 70 is further facilitated by the difference in roll speeds, which produces a rubbing contact of the roll surfaces. Glue is taken from the surface of roll 70 by the ribs of roll 65 and applied in transverse stripes to the facing web 63. Any excess of glue in puddle 77 runs off at the ends of the rolls and is caught by any suitable trough (not shown).

In some cases a glue applying roll having a smooth cylindrical periphery may be substituted for roll 65, and in that case, glue will be supplied all over the surface of facing web 63.

The combined web, consisting of the corrugated web and the facing web adhesively secured to it, may be carried any suitable distance between belt stretch 36 and chain stretches 30, to insure proper adhesion of the webs by hardening or "setting" of the glue, or additional conveying devices may be provided to conduct the combined web and retain its parts in contact to a desired point of delivery or utilization.

In many cases it is desired to wind the faced web in roll form, and any suitable winding mechanism may be provided. Difficulty has, however, been experienced in the ordinary rolling or winding mechanism employed for this purpose, in which the roll has usually been driven from its center or shaft, involving various difficulties, such as a variation in driving speed, due to the variation in roll diameter and therefore in its peripheral speed. To do away with these difficulties and to provide an improved and simple winding mechanism, I provide frame uprights or brackets 90 having slots or channels 91 to accommodate the ends or end portions of a roll shaft 92. This shaft serves simply as a center or core for the roll, and a guide to position it longitudinally of the machine. The faced web is conducted to shaft 92 and its end is turned about the shaft to start the roll formation, and the roll is then allowed to rest on any suitable winding pulley or drum, represented in this instance by belt pulley 38; and the roll therefore actually rests upon the belt, which is supported by the drum or pulley. The tractive effect of the belt or pulley therefore rotates the roll in the proper direction at the same surface speed as that of the completed web, and as the roll diameter increases, shaft 92 moves up in its guides 91 until the desired maximum roll diameter, indicated by dot-and-dash lines 95, is reached, and then the roll is removed, another shaft is inserted, and so on. By this simple arrangement no attention need be paid to variation in the speed of drive, since this is automatically taken care of by

the fact that the periphery of the roll is always driven at the same speed, and this is the speed at which the web is supplied to the roll.

For various reasons, and especially because the varying diameter of the roll requires its shaft 92 to be located considerably away from the corrugated rolls or from the ascending stretches of chains 13, web-controlling or retaining and conveying devices, in addition to chains 13, are usually supplied in connection with belt 35. For example, in the present embodiment of the invention, a belt 100 is provided, passing about pulleys 101 on sprocket shaft 32 and about other pulleys 102 on a shaft 103. The lower stretch of belt 100 comes in contact with the upper face of the corrugated web before chains 13 leave the web, and the corrugated formation is therefore properly maintained and the corrugated web is held in proper contact with the facing web, to a point close to roll 95. Since belt pulleys 102 must be located some distance away from the shaft guides 91, guide bars or blades 110 are desirably provided to rest on the upper surface of the corrugated web from a point where the web leaves contact with belt 100 up to a point very close to the lower surface of roll 95. These bars may be pivotally supported on pulley shaft 103, and their rear ends are tapered off approximately to points to bring them as close as possible to the roll of completed material, 95. The blades or guide members 110 may be made of substantial weight to exert flexible pressure on the upper surface of the corrugated web and maintain it in proper contact with the upper stretch of belt 35 substantially up to the point where the completed web passes on to roll 95.

The different moving parts, or groups of parts, may be driven in various ways. It will be sufficient to briefly describe one representative drive arrangement.

A main drive shaft 250 may be driven in any convenient way, for instance, by an electric motor or by a pulley 251 and belt 252 from a countershaft. Shaft 39 of forward belt pulley 37 is driven by a chain 253 from sprockets of suitable diameter from main shaft 250. A pinion near one end of shaft 250 engages a gear 260 of suitable diameter on the shaft of the lower corrugating roll 5, and the other corrugating rolls are driven from the lower roll shaft by suitable gear connections such as the gear 200 and 201, previously mentioned.

Chains 12 may be driven by the sprockets on shaft 15, which is connected by a pinion 265 to a gear 266 on shaft 8 of primary corrugating roll 6. Chains 13 may be driven by the sprockets on shaft 26 which is connected by a chain 270 and sprockets to shaft 8. The primary driving member, that is shaft 78 of the glue mechanism, may be driven by a chain 275 and suitable sprockets from main shaft 250. Belts 100 are driven by their pulleys 101 on sprocket shaft 32.

I claim:

1. Mechanism for corrugating sheet material, comprising a roll having a corrugated surface, and flexible web guiding and retaining bands, at least one of the bands being arranged to overlie the corrugated surfaces of the roll and move therewith and to retain an interposed sheet of material on the roll, and at least one other band being arranged to travel with the roll and to lie thereon substantially below the level of the corrugations and to strip the web from the roll.

2. Mechanism for corrugating sheet material, comprising a plurality of rolls having corrugated surfaces, and a flexible web guiding and retaining band, arranged to move with the rolls and to overlie the corrugated surface of one roll and retain an interposed web of material to be corrugated on the roll and to lie upon another roll substantially below the level of the corrugations thereon and to strip the web from the roll.

3. Mechanism for corrugating sheet material, comprising a roll having a corrugated surface, and flexible web guiding and retaining bands, at least one of the bands being arranged to overlie the corrugated surface of the roll and move therewith at the same surface speed and to retain an interposed web of material on the roll, and at least one other band being arranged to underlie the web in a depressed portion of the roll substantially below the level of the corrugations thereon and to strip the web from the roll.

4. Mechanism for corrugating sheet material, comprising a roll having a longitudinally corrugated surface, and flexible web guiding and retaining chains, at least one of the chains being arranged to overlie the corrugated surfaces of the roll and move therewith at the same surface speed and to retain an interposed sheet of material on the roll, and at least one other chain being arranged to travel in an annular roll channel substantially below the level of the corrugations and under the sheet and to strip the sheet from the roll.

5. Corrugating mechanism comprising a series of at least two corrugating rolls having at least one line of corrugating contact, and means traveling with the rolls at substantially the same surface speed for positively directing a web of sheet material in contact with the corrugations of successive rolls, and also moving between the rolls at the line of contact and stripping the web from one roll and applying it to the next.

6. Corrugating mechanism comprising a series of at least two corrugating rolls having at least one line of corrugating contact, and means traveling with the rolls at substantially the same surface speed for positively directing a web of sheet material in contact with the corrugations of successive rolls, and also moving between the rolls at the line of contact, stripping the web from one roll and applying it to the next, and traveling means engaging the web and maintaining its corrugated formation as it moves away from the last corrugating roll.

7. Corrugating mechanism comprising a series of corrugating rolls having a plurality of lines of corrugating contact, and traveling means for positively directing a web of sheet material about large circumferential portions of successive rolls, and between the rolls at the successive contact lines, retaining the web in contact with the successive corrugating surfaces, and stripping the web from one roll and applying it to the next at each roll contact line.

8. Corrugating mechanism comprising a series of corrugating rolls having a plurality of lines of corrugating contact, and traveling means for positively directing a web of sheet material about large circumferential portions of successive rolls, and between the rolls at the successive contact lines, retaining the web in contact with the successive corrugating surfaces, stripping the web from one roll and applying it to the next at each roll contact line, and traveling means engaging opposite faces of the web and maintaining its corrugated formation as it moves away from the last corrugating roll.

9. Corrugating mechanism comprising a series of rolls having corrugated surfaces in approximate contact at a plurality of points, and flexible traveling bands arranged to guide and retain a web of material to be corrugated in contact with the corrugated roll surfaces and to strip the web from one roll and apply it to the next succeeding roll substantially at the point of roll contact.

10. Corrugating mechanism comprising a series of rolls having corrugated surfaces in approximate contact at a plurality of points and flexible traveling endless chains arranged to guide and retain a web of material to be corrugated in contact with the corrugated roll surfaces and to strip the web from one roll and apply it to the next succeeding roll substantially at the point of roll contact.

11. Corrugating mechanism comprising a series of corrugating rolls, each roll in the series having its corrugations interfitting those of at least one adjacent roll, and means for definitely guiding and retaining a web of material to be corrugated over large circumferential portions of the successive rolls, said means comprising flexible bands arranged at opposite surfaces of the web and driven at roll surface speed around circumferential portions of the successive rolls and between the rolls at the points of approximate roll contact.

12. Corrugating mechanism comprising a series of corrugating rolls, each roll in the series having its corrugations interfitting those of at least one adjacent roll, and means for definitely guiding and retaining a web of material to be corrugated over large circumferential portions of the successive rolls, said means comprising flexible bands arranged at opposite surfaces of the web and driven at roll surface speed around circumferential portions of the successive rolls and between the rolls at the points of approximate roll contact, one of the bands as it passes about each roll being accommodated in an annuler channel in the roll substantially below the level of the roll corrugations, and another band at the opposite surface of the web passing about the crests of the roll corrugations to retain the interposed web thereon.

13. Corrugating mechanism comprising a series of corrugating rolls, each roll in the series having its corrugations interfitting those of at least one adjacent roll, and means for definitely guiding and retaining a web of material to be corrugated over large circumferential portions of the successive rolls, said means comprising flexible bands arranged at opposite surfaces of the web and driven at roll surface speed around circumferential portions of the successive rolls and between the rolls at the points of approximate roll contact, one of the bands as it passes about each roll being accommodated in an annular channel in the roll substantially below the level of the roll corrugations, and another band at the opposite surface of the web passing about the crests of the roll corrugations to retain the interposed web thereon, the band located in the channel of one roll being arranged to pass about the crests of the corrugations of the next successive roll and to strip the corrugated web from the one roll and apply it to the next.

14. Corrugating mechanism comprising a series of corrugating rolls, each roll in the series having its corrugations interfitting those of at least one adjacent roll, and means for definitely guiding and retaining a web of material to be corrugated over large circumferential portions of the successive rolls, said means comprising flexible endless chains arranged at opposite surfaces of the web and driven at roll surface speed around circumferential portions of the successive rolls and between the rolls at the points of approximate roll contact.

15. Corrugating mechanism comprising a series of corrugating rolls, each roll in the

series having its corrugations interfitting those of at least one adjacent roll, and means for definitely guiding and retaining a web of material to be corrugated over large circumferential portions of the successive rolls, said means comprising flexible endless chains arranged at opposite surfaces of the web and driven at roll surface speed around circumferential portions of the successive rolls and between the rolls at the points of approximate roll contact, one of the chains as it passes about each roll being accommodated in annular channel in the roll substantially below the level of the roll corrugations, and another chain at the opposite surface of the web passing about the crests of the roll corrugations to retain the interposed web thereon.

16. Corrugating mechanism comprising a series of corrugating rolls, each roll in the series having its corrugations interfitting those of at least one adjacent roll, and means for definitely guiding and retaining a web of material to be corrugated over large circumferential portions of the successive rolls, said means comprising flexible endless chains arranged at opposite surfaces of the web and driven at roll surface speed around circumferential portions of the successive rolls and between the rolls at the points of approximate roll contact, one of the chains as it passes about each roll being accommodated in annular channel in the roll substantially below the level of the roll corrugations, and another chain at the opposite surface of the web passing about the crests of the roll corrugations to retain the interposed web thereon, the chain located in the channel of one roll being arranged to pass about the crests of the corrugations of the next successive roll and to strip the corrugated web from one roll and apply it to the next.

17. Corrugating mechanism comprising a series of rolls having corrugated surfaces, the surface of each roll approximately interfitting those of the next roll in the series along a pressing line parallel to the roll axes, and a plurality of flexible web retaining, guiding and stripping bands arranged to carry a web of sheet material to be corrugated in a circuitous course over and between the rolls, the bands being arranged to move substantially at roll-surface speed, each band being arranged to alternately underlie the web as it passes about one roll and to retain the web on the corrugations of the next roll in the series, and to strip the web from one roll and apply it to the next one.

18. Corrugating mechanism comprising a series of rolls having longitudinal surface corrugations and having their axes alternately offset, the corrugations of each roll substantially interfitting those of at least one adjacent roll, and continuous, traveling flexible web guiding bands arranged at opposite sides of a web of sheet material to be corrugated, and passing about major portions of the successive roll circumferences and between adjacent rolls at each point of approximate roll contact, the rolls being provided with annular channels, each band passing alternately through one of the roll channels and then about the crests of the corrugations of the next roll to hold the interposed web thereon.

19. Corrugating mechanism comprising a series of main corrugating rolls having substantially interfitting corrugations, a primary corrugating roll, and traveling bands arranged at opposite surfaces of a web of sheet material to be corrugated, one of the bands being arranged to underlie the web as it passes about a circumferential portion of the primary roll and another band being arranged to overlie the web and retain it upon the crests of the corrugations as it passes about a large circumferential portion of the primary roll.

20. Corrugating mechanism comprising a series of main corrugating rolls having substantially interfitting corrugations, a primary corrugating roll, and traveling bands arranged at opposite surfaces of a web of sheet material to be corrugated, one of the bands being arranged to underlie the web as it passes about a circumferential portion of the primary roll and another band being arranged to overlie the web and retain it upon the crests of the corrugations as it passes about a circumferential portion of the primary roll, the bands being arranged to then direct and retain the web in contact with the successive main-roll corrugations, and to strip the web from each roll and apply it to the succeeding one.

21. Corrugating mechanism comprising a series of corrugating rolls, traveling bands arranged to direct and retain a web of material to be corrugated in contact with successive roll surfaces, and traveling web engaging and directing members arranged to retain the web in corrugated formation as it moves away from the last roll in the series.

22. Corrugating mechanism comprising a series of corrugating rolls, traveling bands arranged to direct and retain a web of material to be corrugated in contact with successive roll surfaces, the bands engaging one web surface being directed in contact with the corrugated web after it leaves the last roll in the series, a traveling web-engaging and directing member arranged to retain the web in contact with the last named bands as they move away from the last roll, and web-guiding and retaining blades arranged to retain the web in contact with a portion of the surface of the last corrugating roll after the web is free from certain of the

guide bands and until it is engaged by said traveling member.

23. Corrugating mechanism comprising a series of corrugating rolls, a system of traveling web guiding and retaining bands arranged substantially at opposite sides of the roll series, certain of the bands having a course of travel away from the last roll in the series, and a traveling belt arranged to retain the corrugated web in contact with the last named bands in the stated course of travel, and retain the corrugations in proper form.

24. Corrugating mechanism comprising a series of corrugating rolls, a system of traveling web guiding and retaining bands arranged substantially at opposite sides of the roll series, certain of the bands having a course of travel away from the last roll in the series, and a traveling belt arranged to retain the corrugated web in contact with the last named bands in the stated course of travel, and retain the corrugations in proper form, and fixed guide fingers retaining the web in contact with a portion of the last roll surface and directing it to said belt.

25. Corrugating mechanism comprising a series of corrugating rolls, traveling means for directing and retaining a web of material in contact with successive roll surfaces, means for applying a web of facing material to the corrugated web while it is definitely retained in proper corrugated formation, and means for supplying adhesive prior to web contact to connect the webs.

26. Corrugating mechanism comprising a series of corrugating rolls, traveling means for directing and retaining a web of material in contact with successive roll surfaces, means for applying a web of facing material to the corrugated web while it is definitely retained in proper corrugated formation and means for supplying adhesive prior to web contact to connect the webs and traveling means for retaining the webs in contact and maintaining the corrugations of the corrugated web in proper form during a substantial length of movement.

27. Corrugating mechanism comprising a series of corrugating rolls, traveling means arranged to direct and retain a web of material to be corrugated in contact with successive roll surfaces, means for directing a web of a facing material and applying it to the corrugated web while the latter is retained in proper corrugated form, and means for applying adhesive to secure the webs together prior to web contact.

28. Corrugating mechanism comprising a series of corrugating rolls, traveling means arranged to direct and retain a web of material to be corrugated in contact with successive roll surfaces, means for applying transverse stripes of glue to a surface of a facing web in positions corresponding to subsequent points of contact with ribs of the corrugated web, and means for directing and applying the facing web to the corrugated web while the latter is retained in proper corrugated form.

29. Corrugating mechanism comprising means for corrugating a web of sheet material, means for bringing a web of facing material in contact with the corrugated web while the ribs of the latter are retained in form, a glue roll having longitudinal ribs corresponding to the spacing of the ribs of the corrugated web, means for supplying glue to the glue roll ribs, and means for driving the glue roll in contact with a surface of facing web to apply transverse glue stripes to the web in spaced relation corresponding to subsequent contact points with the ribs of the corrugated web.

30. Corrugating mechanism comprising means for corrugating a web of sheet material, means for bringing a web of facing material in contact with the corrugated web, a glue roll in contact with a surface of the facing web, a pair of glue supply rolls, one of which is arranged to supply glue to the glue roll, the glue supply rolls having engaging surfaces, and means for supplying glue to the trough formed by said engaging roll surfaces.

31. Corrugating mechanism comprising means for corrugating a web of sheet material, means for bringing a web of facing material in contact with the corrugated web, a glue roll in contact with a surface of the facing web, a pair of glue supply rolls, one of which is arranged to supply glue to the glue roll, the glue supply rolls having engaging surfaces, means for supplying glue to the trough formed by said engaging roll surfaces, and means for driving the glue supply rolls so that their engaging faces move downward.

32. Corrugating mechanism comprising means for corrugating a web of sheet material, means for bringing a web of facing material in contact with the corrugated web, a glue roll in contact with a surface of the facing web, a pair of glue supply rolls, one of which is arranged to supply glue to the glue roll, the glue supply rolls having engaging surfaces, means for supplying glue to the trough formed by said engaging roll surfaces, and means for driving the glue supply rolls at different peripheral speeds to produce a rubbing contact.

33. Corrugating mechanism comprising means for corrugating a web of sheet material, means for bringing a web of facing material in contact with the corrugated web while the ribs of the latter are retained in form, a glue roll in contact with a surface of the facing web, a pair of glue supply rolls, one of which is arranged to supply glue to the glue roll, the glue supply rolls having

engaging surfaces, and means for supplying glue to the trough formed above said engaging roll surfaces.

34. Corrugating mechanism comprising means for corrugating a web of sheet material, means for bringing a web of facing material in contact with the corrugated web while the ribs of the latter are retained in form, a glue roll in contact with a surface of the facing web, a pair of glue supply rolls, one of which is arranged to supply glue to the glue roll, the glue supply rolls having engaging surfaces, and means for supplying glue to the trough formed above said engaging roll surfaces, and means for driving the glue supply rolls at different peripheral speeds to produce a rubbing contact.

35. Corrugating mechanism comprising means for producing transverse corrugations on a web of sheet material, means for applying a web of facing material to the corrugated web while the latter is retained in corrugated formation, means for supplying adhesive prior to web contact to secure the webs, and means for conveying the combined webs away from the corrugating means and retaining the corrugations in proper form during such travel.

36. Corrugating mechanism comprising means for producing transverse corrugations on a web of sheet material, means for winding the corrugated web in roll form, and means for retaining the corrugations in proper shape substantially up to the point of winding.

37. Corrugating mechanism comprising means for producing transverse corrugations on a web of sheet material, a winding center for the completed web of corrugated material on which the web is wound in roll form, and means for driving the roll of completed material by surface traction.

38. Corrugating mechanism comprising means for producing transverse corrugations on a web of sheet material, a winding center for the completed web of corrugated material on which the web is wound in roll form, means for driving the roll of completed material by surface traction, and means for guiding the roll center and retaining the roll in proper relation to the driving means as its diameter increases.

39. Corrugating mechanism comprising means for producing transverse corrugations on a web of sheet material, a moving friction element arranged to support and drive a roll of the completed corrugated material, roll center guides, and a roll center arranged in the guides and adapted to centrally direct a roll of completed material as it is wound upon the center and driven by traction from said friction element.

40. Corrugating mechanism comprising means for producing transverse corrugations on a web of sheet material, a winding center for the completed web of corrugated material on which the web is wound in roll form, and means for driving the roll of completed material by surface traction, and traveling means for directing the web and retaining its corrugations in proper shape from the corrugating means substantially to the point where it is wound upon the roll.

41. Corrugating mechanism comprising means for producing transverse corrugations on a web of sheet material, a winding center for the completed web of corrugated material on which the web is wound in roll form, and means for driving the roll of completed material by surface traction, a traveling conveyor engaging and directing the web to a point adjacent to the roll of completed material, and guide bars engaging a surface of the web and directing the latter from said conveyor to substantially the point of contact with the roll of completed material.

42. Corrugating mechanism comprising means for producing transverse corrugations on a web of sheet material, means for applying a web of facing material to the corrugated web while the latter is retained in corrugated formation, means for supplying adhesive prior to web contact to secure the webs, and means for winding the faced web in roll form while the corrugations are retained in proper shape.

43. Corrugating mechanism comprising means for producing transverse corrugations on a web of sheet material, means for applying a web of facing material to the corrugated web while the latter is retained in corrugated formation, a winding center for the faced web of corrugated material, on which the web is wound in roll form, and means for driving the roll of completed material by surface traction applied to the facing web at the roll periphery.

44. Corrugating mechanism comprising means for producing transverse corrugations on a web of sheet material, means for applying a web of facing material to the corrugated web while the latter is retained in corrugated formation, a winding center for the faced web of corrugated material, on which the web is wound in roll form, and means for driving the roll of completed material by surface traction, and means for guiding the roll center and retaining the roll in the proper relation to the driving means as its diameter increases.

45. Corrugating mechanism comprising means for producing transverse corrugations on a web of sheet material, means for applying a web of facing material to the corrugated web while the latter is retained in corrugated formation, means for supplying adhesive prior to web contact to secure the webs, means for conveying the combined webs away from the corrugating means and

retaining the corrugations in proper form during such travel, a rotary friction element arranged to support and drive a roll of completed material, roll center guides, and a roll center arrangement in the guides and adapted to centrally direct a roll of completed material as it is wound upon the center and driven by traction from said friction element.

46. Corrugating mechanism comprising means for producing transverse corrugations on a web of sheet material, means for applying a web of facing material to the corrugated web while the latter is retained in corrugated formation, means for supplying adhesive prior to web contact to secure the webs, means for conveying the combined webs away from the corrugating means and retaining the corrugations in proper form during such travel, a rotary friction element arranged to support and drive a roll of completed material, roll center guides, and a roll center arrangement in the guides and adapted to centrally direct a roll of completed material as it is wound upon the center and driven by traction from said friction element, and traveling means for directing the web and retaining its corrugations in proper shape from the corrugating means substantially to the point where it is wound upon the roll.

47. Corrugating mechanism comprising means for producing transverse corrugations on a web of sheet material, means for applying a web of facing material to the corrugated web while the latter is retained in corrugated formation, means for supplying adhesive prior to web contact to secure the webs, means for conveying the combined webs away from the corrugating means and retaining the corrugations in proper form during such travel, a rotary friction element arranged to support and drive a roll of completed material, roll center guides, and a roll center arrangement in the guides and adapted to centrally direct a roll of completed material as it is wound upon the center and driven by traction from said friction element, a traveling conveyor engaging and directing the web to a point adjacent to the roll of completed material, and guide bars engaging a surface of the web and directing the latter from said conveyor to substantially the point of contact with the roll of completed material.

48. Corrugating mechanism comprising a series of corrugating rolls, traveling bands arranged to direct a web of sheet material to be corrugated over large circumferential portions of the successive rolls, to retain the corrugated web positively in connection with the roll corrugations and to strip the web from each roll and apply it to the next one, means for advancing and applying a sheet of facing material to the corrugated web while the latter is in contact with the last corrugating roll, means for supplying adhesive to connect the webs prior to web contact, a continuous conveyor belt engaging a face of the completed web from a point adjacent to the last corrugating roll to a point of delivery, and traveling means engaging the opposite face of the completed web and holding it in contact with said belt and retaining the corrugations in the proper form up to said delivery point.

49. Corrugating mechanism comprising a series of corrugating rolls, traveling bands arranged to direct a web of sheet material to be corrugated over large circumferential portions of the successive rolls, to retain the corrugated web positively in connection with the roll corrugations and to strip the web from each roll and apply it to the next one, means for advancing and applying a sheet of facing material to the corrugated web while the latter is in contact with the last corrugating roll, means for supplying adhesive to connect the webs prior to web contact, a continuous conveyor belt engaging a face of the completed web from a point adjacent to the last corrugating roll to a winding position, traveling means engaging the other surface of the web and retaining it in contact with the conveyor substantially to said winding position, a pulley about which said conveyor belt passes at said winding position, roll center guides extending away from the pulley, and a roll center movably mounted in the guides and adapted to direct the center of a roll of completed material as it rests upon said pulley and is driven by surface traction to wind the completed material in roll form.

50. A method of producing corrugated sheet material, comprising passing a web of sheet material through a circuitous course in contact with a plurality of corrugating surfaces and subjecting the web to repeated corrugating pressures, and positively guiding and directing the web throughout its course and retaining the formed corrugations in proper shape.

51. A method of producing corrugated sheet material, comprising passing a web of sheet material through a circuitous course in contact with a plurality of corrugating surfaces and subjecting the web to repeated corrugating pressures, and positively guiding and directing the web throughout its course and retaining the formed corrugations in proper shape to a delivery point distant from the corrugating surfaces.

52. A method of producing the corrugated sheet material comprising passing a web of sheet material through a circuitous course in contact with a plurality of corrugating surfaces and subjecting the web to repeated corrugating pressures, and positively guiding and directing the web

throughout its course by web-engaging devices which travel with the web and retain the formed corrugations in proper shape.

53. A method of producing the corrugated sheet material comprising passing a web of sheet material through a circuitous course in contact with a plurality of corrugating surfaces and subjecting the web to repeated corrugating pressures, and positively guiding and directing the web throughout its course by web-engaging devices which travel with the web and retain the formed corrugations in proper shape to a delivery point distant from the corrugating surfaces.

54. A method of producing faced corrugated sheet material comprising passing a sheet of material to be corrugated in contact with a plurality of corrugating surfaces and subjecting the sheet to a plurality of corrugating pressures, and advancing, applying, and adhesively securing a web of facing material to the corrugated sheet while the latter is retained in proper corrugated form.

55. A method of producing faced corrugated sheet material comprising passing a sheet of material to be corrugated in contact with a plurality of corrugating surfaces and subjecting the sheet to a plurality of corrugating pressures, and advancing, applying, and adhesively securing a web of facing material to the corrugated sheet while the latter is retained in proper corrugated form, and conveying the combined materials a substantial distance away from the point of web contact to a delivery point and meantime retaining the ribs of the corrugated sheet in proper form.

56. A method of producing faced corrugated sheet material comprising passing a sheet of material to be corrugated in contact with a plurality of corrugating surfaces and subjecting the sheet to a plurality of corrugating pressures, advancing a web of facing material, applying adhesive to a surface of said web, and bringing the adhesively conditioned surface of said web in contact with a face of the corrugated web while the latter is retained in proper corrugated form.

57. A method of producing faced corrugated sheet material comprising passing a sheet of material to be corrugated in contact with a plurality of corrugating surfaces and subjecting the sheet to a plurality of corrugating pressures, advancing a web of facing material, applying adhesive to a surface of said web, bringing the adhesively conditioned surface of said web in contact with a face of the corrugated sheet while the latter is retained in proper corrugated form, and conveying the combined materials a substantial distance away from the point of contact and meantime retaining them in contact to assure proper adhesive connection.

58. A method of producing faced corrugated sheet material comprising passing a sheet of material to be corrugated in contact with a plurality of corrugating surfaces and subjecting the sheet to a plurality of corrugating pressures, advancing a web of facing material, applying adhesive to a surface of said web, bringing the adhesively conditioned surface of said web in contact with a face of the corrugated sheet while the latter is retained in proper corrugated form, conveying the combined materials a substantial distance away from the point of contact and meantime retaining the ribs of the corrugated sheet in proper form.

59. A method of producing faced corrugated sheet material comprising passing a sheet of material to be corrugated in contact with a plurality of corrugating surfaces and subjecting the sheet to a plurality of corrugating pressures, advancing a web of facing material, applying spaced transverse strips of adhesive to a surface of the facing web in positions corresponding to the spacing of the ribs of the corrugated web, bringing the facing sheet in contact with the corrugated sheet with the glue stripes in contact with crests of the corrugations, and advancing the combined materials and retaining them in contact through a substantial course of travel.

60. A method of producing faced corrugated sheet material comprising passing a sheet of material to be corrugated in contact with a plurality of corrugating surfaces and subjecting the sheet to a plurality of corrugating pressures, advancing a web of facing material, supplying spaced transverse stripes of adhesive to a surface of the facing web in positions corresponding to the spacing of the ribs of the corrugated sheet, bringing the facing web in contact with the corrugated sheet while the latter is retained in proper corrugated formation and with the glue stripes in contact with crests of the corrugations, and advancing the combined materials and retaining them in contact and preserving the formation of the corrugations through a substantial course of travel.

61. A method of producing faced corrugated sheet material comprising passing a sheet of material to be corrugated in contact with a plurality of corrugating surfaces and subjecting the sheet to a plurality of corrugating pressures, and winding the corrugated sheet in roll form by traction applied to the roll periphery, the sheet being kept under control to maintain the formed corrugations in proper shape up to the point of winding.

62. A method of producing faced corrugated sheet material comprising passing a web of material to be corrugated in contact with a plurality of corrugating surfaces and subjecting it to a plurality of corrugating

pressures, advancing, applying and adhesively securing a web of facing material to the corrugated web while the latter is retained in proper corrugated form, and winding the combined webs in roll form by traction applied to the facing web at the roll periphery, the combined web being maintained in form up to the point of winding.

63. A method of producing corrugated sheet material, comprising passing a web of sheet material through a circuitous course in contact with a plurality of corresponding surfaces and subjecting the web to repeated corrugating pressures, positively guiding and directing the web throughout its course and retaining the formed corrugations in proper shape to a delivery point distant from the corrugating surfaces, and winding the corrugated web in roll form by traction applied to the roll periphery.

64. A method of producing faced corrugated sheet material comprising passing a sheet of material to be corrugated in contact with a plurality of corrugating surfaces and subjecting the sheet to a plurality of corrugating pressures, advancing, applying, and adhesively securing a sheet of facing material to the corrugated web while the latter is retained in proper corrugated form, and conveying the combined materials a substantial distance away from the point of sheet contact to a delivery point and meantime retaining the ribs of the corrugated web in proper form, and winding the combined materials in roll form by traction applied to the facing web at the roll periphery.

Signed at Brooklyn, N. Y., in the county of Kings and State of New York, this 11th day of Sept., A. D., 1923.

HARRY BRIDGMAN SMITH.