May 28, 1957 M. HUBMEIER 2,793,676

APPARATUS FOR CORRUGATING PAPER OR CARDBOARD

Original Filed April 14, 1952 5 Sheets-Sheet 1

FIG. 1

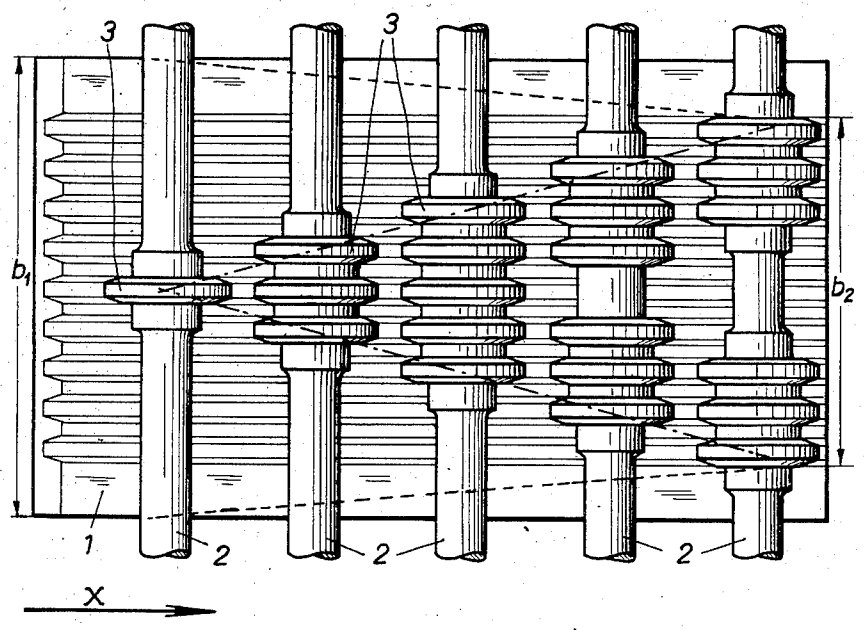


FIG. 2

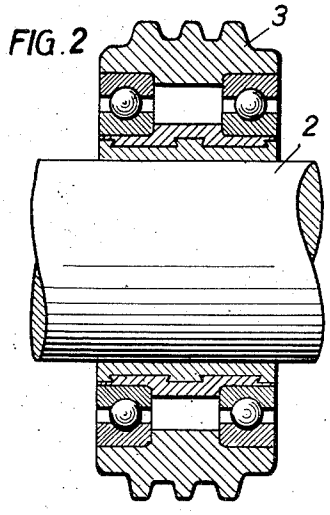
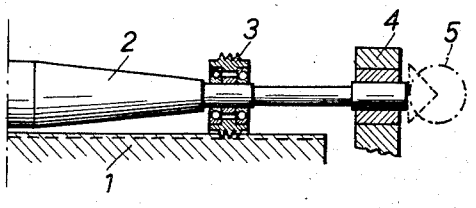


FIG. 3



INVENTOR:
MAX HUBMEIER

BY
Wenderoth, Lind & Ponack
Attys.

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APPARATUS FOR CORRUGATING PAPER OR CARDBOARD

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FIG. 4

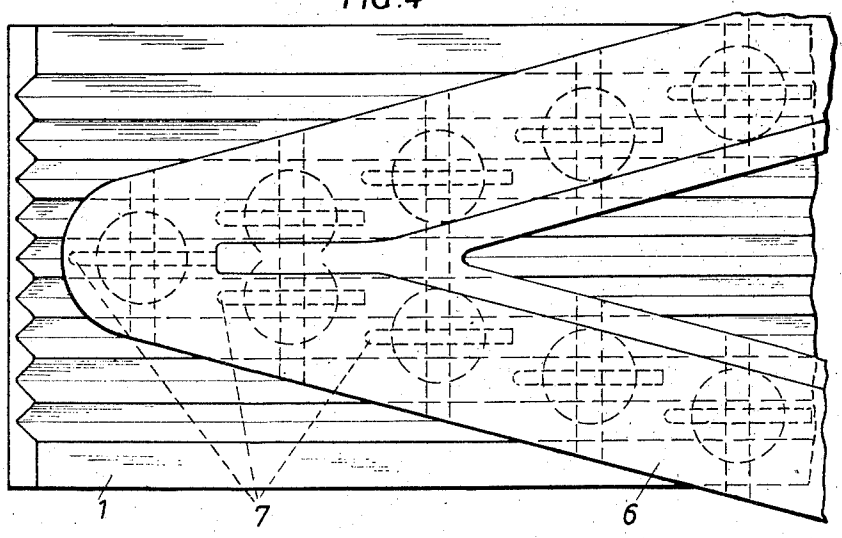


FIG. 5

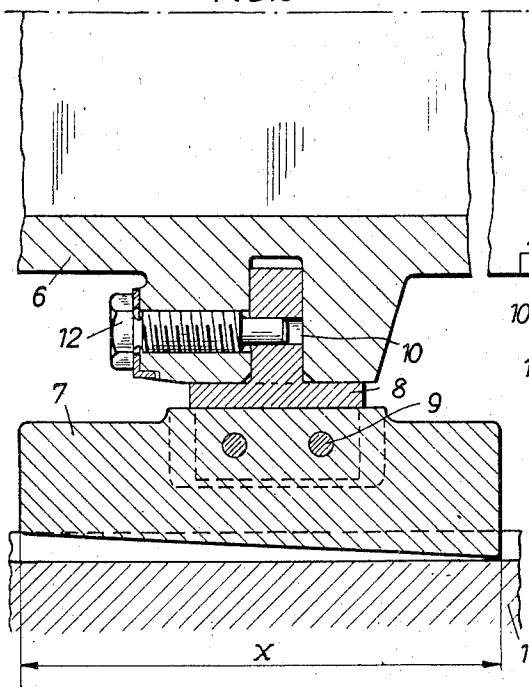
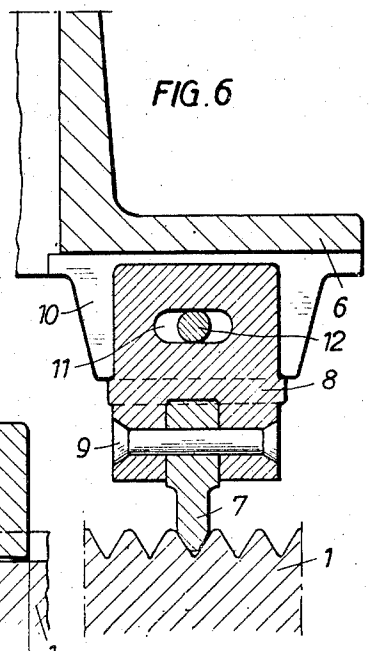


FIG. 6



INVENTOR:
MAX HUBMEIER

BY
Wenderoth, Lind & Ponack
Attys.

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FIG. 7

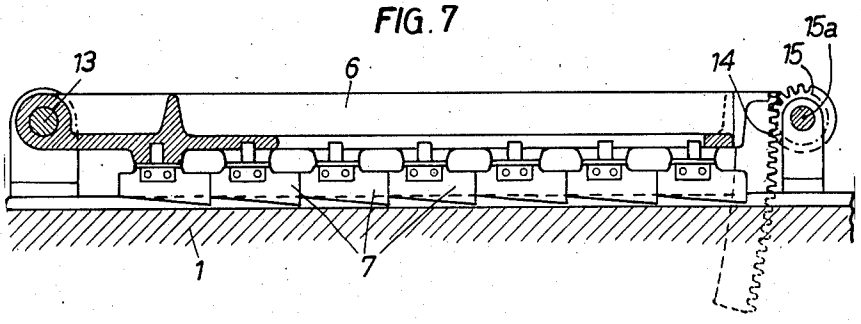
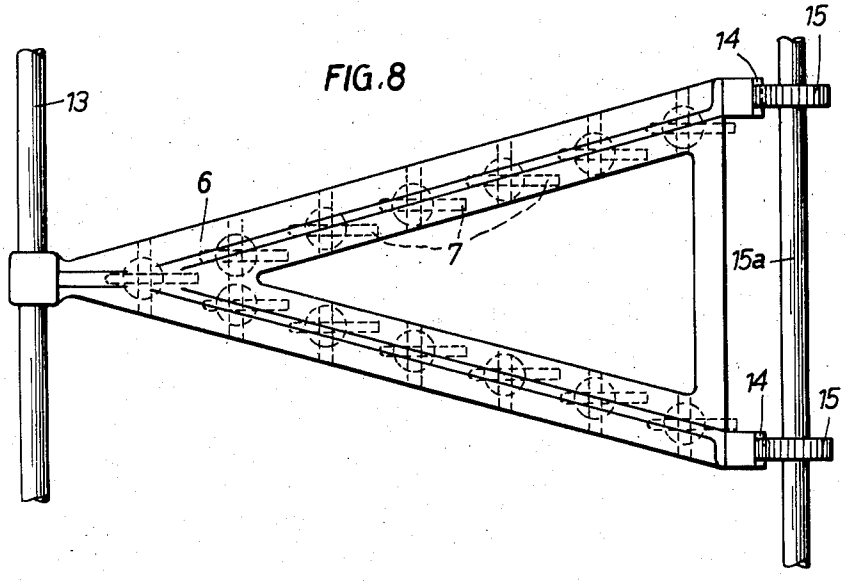


FIG. 8



INVENTOR:
MAX HUBMEIER

BY
Wenderoth, Lind & Ponack,
Attys.

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APPARATUS FOR CORRUGATING PAPER OR CARDBOARD

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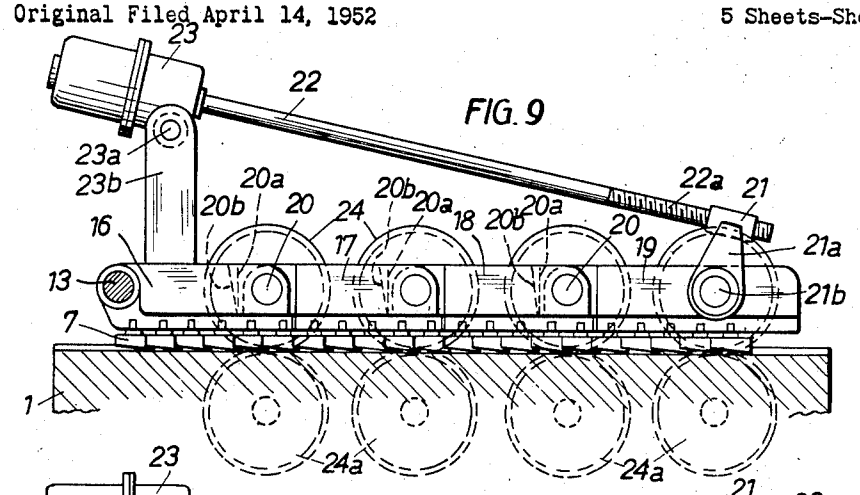


FIG. 9

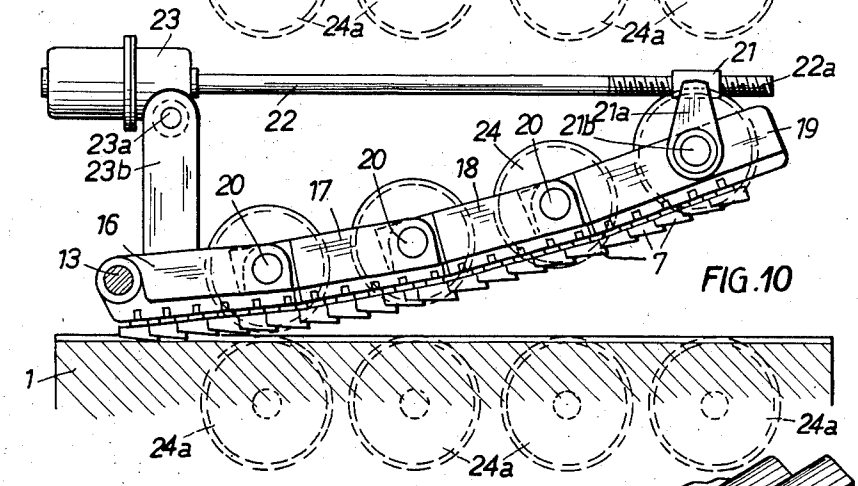


FIG. 10

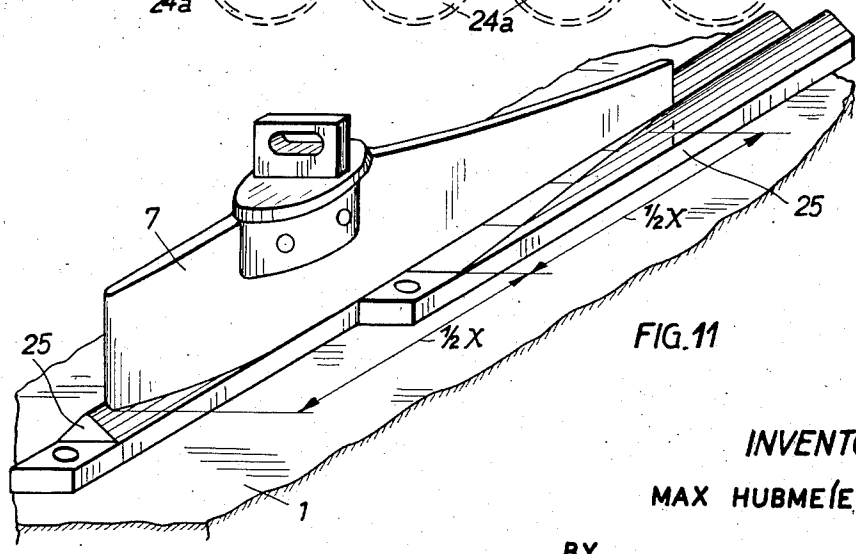


FIG. 11

INVENTOR:
MAX HUBMEIER

BY
Wanderoth, Lind & Ponack
Attys.

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FIG. 12

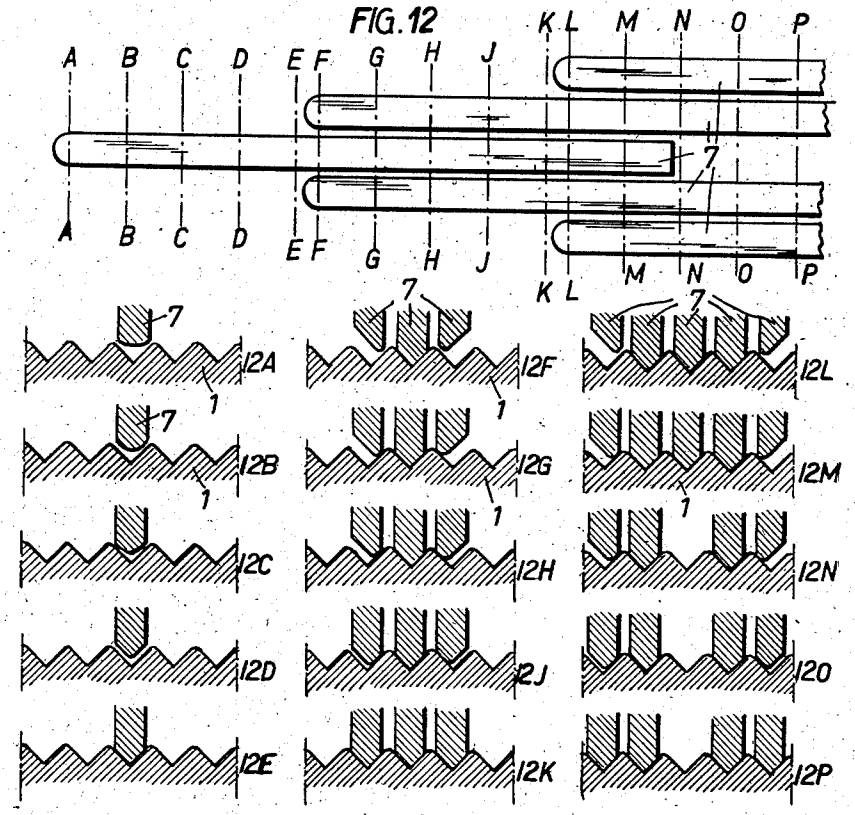
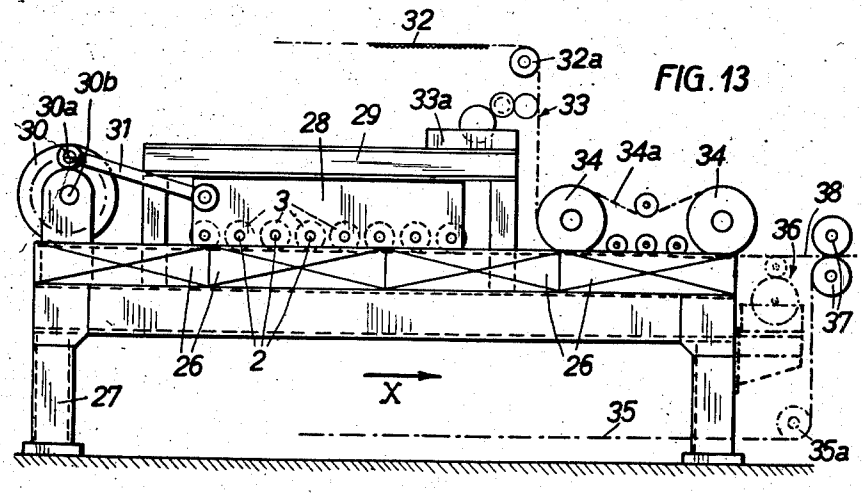


FIG. 13



INVENTOR:
MAX HUBMEIER
BY
Wenderoth, Lind + Ponack
Attys.

United States Patent Office 2,793,676
Patented May 28, 1957

2,793,676

APPARATUS FOR CORRUGATING PAPER OR CARDBOARD

Max Hubmeier, Pforzheim, Germany, assignor to Aktiengesellschaft der Maschinenfabrik von Theodore Bell & Cie., Kriens, Switzerland

Original application April 14, 1952, Serial No. 282,124, now Patent No. 2,710,043, dated June 7, 1955. Divided and this application June 6, 1955, Serial No. 516,703

Claims priority, application Germany April 17, 1951

11 Claims. (Cl. 154—30)

The present invention relates to an apparatus for providing, in continuous operation, a run of paper or cardboard with corrugations extending longitudinally of the said run.

This application is a division of my application Serial No. 282,124, filed April 14, 1952, and now Patent No. 2,710,043 of June 7, 1955.

It has been tried for decades to provide an operable machine for corrugating paper or cardboard in the direction of its run, not in order to obtain longitudinally corrugated paper or cardboard as a separate commercial product but rather in order to manufacture, mechanically and in continuous operation, so-called crosswise corrugated board or double-double board comprising at least two corrugated layers the corrugations of which run crosswise of each other, with or without an intermediate smooth sheet.

Two basically different methods have shown to be applicable for producing longitudinally corrugated paper or cardboard.

According to the first of these methods, one begins from the outset to press all the corrugations, whereby a longitudinally corrugated fan is produced from the flat paper or cardboard run by continuous engagement between top and bottom pressing members, with the said paper or cardboard run tapering progressively in breadth. For this purpose, two radially tapering plates engaging each other and having grooves of continuously changing transverse profile may be used. Alternately, pairs of rollers of corresponding shape, or corresponding rollers cooperating with such a grooved plate may be used.

With the second method, one first presses only one or two longitudinal corrugations along the center line of the paper or cardboard run, and one begins to press the two adjacent corrugations right and left thereof only when the preceding corrugations have been completed or nearly so, and so on. For carrying out this method, various devices have been suggested as well, among others with corresponding corrugating members engaging each other from above and from below, or with pressing rollers in V-shaped arrangement above a cylinder having parallel grooves. Other suggestions related to the use of a larger number of roller pairs arranged one behind the other, whereby again one pair of longitudinal corrugations after the other are formed continuously, beginning from the center, each pair of rollers producing one pair of corrugations.

Besides, it has been proposed, in order to avoid entirely the difficulties of producing longitudinal corrugations, to manufacture crosswise corrugated cardboard by assembling sheets of ordinary transversally corrugated cardboard, these sheets being cut to the same size but differing in the orientation of the corrugations, which in each sheet run at right angles to those of the other sheet. This method, however, does not permit to manufacture

crosswise corrugated board in continuous runs and at high working speeds.

Therefore, it has not yet been possible up to now to manufacture longitudinally corrugated paper or cardboard, or crosswise corrugated cardboard or double-double board, by means of machines and in continuous operation.

It is the main object of the present invention to provide means for producing longitudinally corrugated paper or cardboard, and crosswise corrugated cardboard or double-double board, in continuous process and at high speeds of operation.

Various embodiments of the invention are shown by way of example in the accompanying drawings in which:

Fig. 1 is a plan view of a corrugating apparatus comprising a grooved plate and a set of grooving rollers cooperating with it;

Fig. 2 is an axial section through a grooving roller of the apparatus according to Fig. 1;

Fig. 3 shows, in cross-section, the grooving roller represented in Fig. 2, with half of its shaft;

Fig. 4 illustrates, in plan view, another embodiment of the grooving apparatus, comprising a grooved plate and grooving shoes cooperating with it;

Figs. 5 and 6 are a longitudinal and a transversal section, respectively, through a grooving shoe of the apparatus shown in Fig. 4;

Figs. 7 and 8 show, in longitudinal section and in plan view, respectively, part of an apparatus of the kind shown in Figs. 5 and 6, in which the frame carrying the grooving shoes can be swung upwards;

Figs. 9 and 10 illustrate in lateral view, in two different positions, an alternative arrangement for swinging the grooving shoes clear of the grooved plate;

Fig. 11 shows, in perspective, a grooving shoe cooperating with folding bars, in still another alternative arrangement;

Fig. 12 diagrammatically indicates the disposition of the grooves in a grooved plate intended for cooperation with the grooving shoes; Figs. 12A to 12P are fifteen cross-sections through the cooperating active portions of the grooving shoes and grooved plate, taken on lines A—A to P—P of Fig. 12, respectively.

Fig. 13 is a diagrammatic lateral view of a further embodiment of an apparatus according to the invention, including a paper corrugating device with a reciprocating set of grooving rollers and with devices for bonding further layers of transversely corrugated and/or smooth paper to the longitudinally corrugated run of paper.

In Fig. 1, the reference numeral **1** indicates a stationary plate provided with parallel grooves the profile of which corresponds to that of the longitudinal corrugations it is desired to obtain in a run of paper or cardboard. A number of pressing devices cooperating with the plate **1** are arranged above the latter, each of these devices comprising a shaft **2** on which grooving rollers **3** are rotatably mounted. The run of paper or cardboard to be corrugated is introduced from the left and proceeds between the plate **1** and the rollers **3** in the direction indicated by the arrow X. A first corrugation in the paper or cardboard is produced by the roller on the first shaft from the left along the center line of the paper run; the rollers on the second shaft produce a further corrugation on each side of the said first one, those on the third shaft produce two further corrugations, and so on. Thus, about half as many shafts with their rollers are required as there are to be corrugations in the finished longitudinally corrugated paper run. The initial breadth b_1 of the paper run in this process diminishes to the final effective breadth b_2 of the corrugated run.

The particular advantage of this arrangement is that

the paper or cardboard is guided in the stationary plate 1 during the whole corrugating operation from the moment it is seized by the first roller to that at which it leaves the last rollers. The plate 1 may be extended to the right to a device (not shown) in which the corrugated paper or cardboard is bonded to a flat covering layer of paper or cardboard or directly to a layer of transversely corrugated paper or cardboard. During the bonding operation, the longitudinally corrugated run still rests on the grooved plate 1 and does not leave the latter until after its corrugations have been fixed by the covering bonded at least to one of its faces.

The grooved plate 1 is heated during operation. In order that the grooving rollers 3 may follow the lateral dilatation of the plate as its temperature varies depending on the rate of heating, it is essential that these rollers be laterally displaceable on their shafts 2, as shown in Figs. 2 and 3. The ball bearings shown in these figures may, however, be omitted if the shafts 2, which are supported at their ends in bearings 4, are to drive the rollers 3 by means of keys or splines; in this case lateral displaceability of the rollers on the shafts may be provided by plain bearings. The shafts 2 are then driven from a common driving shaft by means of a pair of bevel gearwheels 5.

In the embodiment shown in Figs. 4, 5 and 6 grooving shoes 7 are provided instead of the rollers 3. These are mounted on a frame 6 which is V-shaped in plan view. Here again, it is essential that the grooving shoes 7 be mounted in the frame 6 so as to be easily displaceable laterally. For this purpose, an intermediate member 8 is provided, to which the grooving shoe 7 is fixed by rivets 9, while the intermediate member 8 itself is guided in a guide slot 10 of the frame 6 so as to be laterally displaceable in the latter. To prevent the intermediate member 8 from falling out, a retaining screw 12 is provided in the frame 6, which screw extends into an elongated hole 11 of the member 8.

While it is comparatively easy to introduce a new run of paper or cardboard into the device when rollers are used as a grooving means, this operation presents some difficulties when grooving shoes are used with a stationary grooved plate. In order to facilitate it, the support 6 is swingably mounted on a shaft 13 and provided with a pair of toothed segments 14 each engaged by a gearwheel 15 mounted on a shaft 15*a*, as shown in Figs. 7 and 8, so that it can be swung up and down in an easy way by rotating this shaft.

When a new run of paper is to be introduced, the frame 6 is raised, the front portion of the paper run is placed on the grooved plate 1, and the frame 6 with the shoes 7 is gradually lowered. With this arrangement, however, only the first five or six pairs of shoes engage the paper one after the other, while the remaining shoes begin almost simultaneously to press down the paper into the grooves of the plate 1.

This drawback is avoided in the arrangement shown in Figs. 9 and 10, in which the frame comprises several parts 16, 17, 18 and 19 which are swingable individually one after the other about shafts 20 each linking one of the said parts to the adjacent one. Each part carries five or six pairs of shoes.

To swing the parts 16 to 19 into and out of working position, a geared electric motor 23 is swingably mounted on a trunnion 23*a* itself supported by a pillar 23*b* mounted on the grooved plate 1. A spindle 22 driven by the motor 23 and having a threaded portion 22*a* engages a nut 21 which is carried on an arm 21*a* itself swingably supported by a shaft 21*b* extending through the extreme part 19 of the frame. Relative angular displacement about the shafts 20 of the adjacent parts 16 to 19 of the frame is limited by cooperating abutments 20*a*, 20*b*.

To raise the parts 16 to 19 of the frame from their working position shown in Fig. 9, into the position shown in Fig. 10, the motor 23 drives the spindle 22 in such a direction that the nut 21 is screwed to the left along the said spindle. Thereby, the part 19 of the frame is swung anti-clockwise about the shaft 20 by which it is linked to part 18, until the abutment 20*a* of part 19 contacts the abutment 20*b* of part 18. Thereupon, both parts 18 and 19 continue to move in unison about the shaft 20 linking parts 17 and 18; similarly, after the abutments 20*a* and 20*b* of parts 17 and 18, respectively, have met, the parts 18 and 19 continue to rise jointly with part 17, and finally the whole frame, including part 16 as well, swings upwards about shaft 13 into the position shown in Fig. 10. After the front portion of a paper run has been placed on the grooved plate 1, the motor 23 is reversed and the parts 16, 17, 18 and 19 of frame, in this sequence, descend on the paper, so that their shoes press the paper into the grooves of the said plates.

Profiled top driving rollers 24 are rotatably supported on the shafts 20, and corresponding bottom driving rollers 24*a* are lodged within the grooved plate 1 the top surface of which in this case has interruptions through which the bottom rollers 24*a* project into contact with the paper running in the grooves of the plate 1. The profile of each bottom roller 24*a* is the same as the transversal profile of the plate 1 at the point where this roller projects through the latter, so that the surfaces of the rollers and of the plate are flush with each other. The profile of the corresponding top roller 24 is complementary to that of the bottom roller in question, so the top and bottom rollers 24 and 24*a* cooperate for seizing between them the paper. Means (not shown) are provided for driving the rollers for advancing the paper between the plate 1 and the shoes 7 from left to right.

In all the embodiments thus far described, the longitudinal corrugations of the paper or cardboard are obtained by pressure between top and bottom. However, it is possible to obtain these corrugations by way of folding and for this purpose the arrangement shown in Fig. 11 is used. Here, the bottom plate 1 is not provided with grooves but carries a set of folding bars 25 cooperating with the grooving shoes 7. The bars 25, two of which are shown in Fig. 11, are mounted along each other with their front ends in staggered position. Towards these front ends, the bars 25 may be pointed or flattened. While in the foregoing examples the front half (½ x) of the length of each shoe 7 serves for pressing down the paper to form both sides of a corrugation, this part of the shoe length here only serves to fold the paper on the inner side, i. e. the side nearer to the center line of the paper run, against the corresponding folding bar. The outer side of the corrugation is only formed, against the outwardly adjacent bar 25, by the rear half (½ x) of the shoe 7. The shoe 7 thus extends to the rear between the two adjacent bars at least up to the point at which the corrugation has been completed.

This arrangement has the advantage that it permits to form corrugations in paper of poor grade and such brittleness that it scarcely would withstand pressing.

The same effect may be obtained by means of a grooved bottom plate provided that the cross-profile of the grooving shoes 7 is shaped as indicated in Fig. 12 and Figs. 12A to 12P. These figures show successive cross sections of the first five grooving shoes. The first or central grooving shoe should have the symmetrical profile shown in Figs. 12A to 12E, while all other grooving shoes should be shaped as indicated in Figs. 12F to 12P, i. e. they should form the corrugations by unilateral pressure against the inner side of the corresponding groove of plate 1, the outer side of each corrugation being left free to assume its final shape without the application of any pressure.

It is important that at the finished longitudinal corrugations the paper be guided without interruption until

the paper has been bonded to that first overlay sheet, which may consist of flat or of transversely corrugated paper or cardboard. Preferably, the bonding thus takes place while the corrugated paper still is on the grooved plate **1**. For this purpose, a machine as shown in Fig. 13 may be used.

This machine comprises a table-like structure **27** on which are mounted heatable boxes **26** the tops of which provide a grooved support plate for the paper. A separate housing **28** slidably supported by a guide rail **29** carries a set of grooving rollers **3** rotatably mounted on shafts **2**, the arrangement of the grooved plate and the rollers **3** being as shown in Fig. 1. However, the rollers **3** may be replaced by grooving shoes such as those indicated at **7** in Figs. 4 to 6, with the housing **28** replacing the frame **6** shown in these figures. The housing **28** is reciprocated along its guide rail **29** by means of a link rod **31**, which at its opposite end is articulated on a crank pin **30***a* carried by a disc **30**. The latter is fixed on a driving shaft **30***b* which is driven by a motor (not shown) through a suitable transmission.

For introducing a new run of paper, seizing devices, not shown in the drawing, are provided both on the grooved plate formed by the boxes **26**, and on the housing **28**. The paper is introduced into the machine while the housing **28** is in its extreme right-hand position and the front portion of the paper run is placed on the grooved plate with its front edge as far as possible to the right. Thereupon, the reciprocating motion of the housing **28** is initiated, so that the latter moves to the left, in a direction opposite to that indicated by arrow X, and the rollers **3** form the first corrugations in the said front portion of the paper run. As soon as the motion of the housing **28** is reversed and the latter moves to the right in the direction of the arrow X, the said seizing devices on the housing **28** engage the paper and carry it forward over the grooved plate. When the housing **28** again reaches its extreme right hand position, these seizing devices release the paper, while the seizing devices mounted on the boxes **26** engage it. Thus, the paper again remains stationary while the rollers **3** proceed over it to the left, forming a further stretch of the corrugation. At the end of this stroke of housing **28**, the paper again is disengaged from the boxes **26** and seized by the seizing device on housing **28**, and so on. This stepwise advance of the paper continues until the front edge of the paper run has reached the paper advancing devices associated with heating and cooling devices later to be described. Although from this moment the reciprocating motion of the housing no longer is necessary, it is, however, recommended to continue it throughout the time of operation of the machine.

A run of smooth or transversely corrugated paper, the latter being itself preferably already bonded to a smooth overlay run, is indicated at **32**. It arrives continuously from any suitable source (not shown), such as a supply roll or (in the case of transversely corrugated paper) a conventional corrugating machine and is first carried over a roller **32***a* and then over a glue applying device **33** comprising a set of rollers for transporting liquid glue from a reservoir **33***a* to the surface of the paper **32**. Thence, the paper proceeds to an assembling device comprising a pair of rollers **34** over which a felt belt **34***a* is carried. This belt applies the paper run **32** to the longitudinally corrugated paper which at this point still rests on one of the heated boxes **26**, with its corrugations still guided in the grooves of the top face of the box. Both layers of paper are thus glued together.

A further run of smooth paper **35** may be applied from below to the under face of the longitudinally corrugated paper run. Additional devices provided for this purpose are indicated in dash-and-dot lines at the right of Fig. 13. They comprise a device **36**, similar in principle to that indicated at **33**, for applying glue to the under face of the longitudinally corrugated paper after it has left the last-mentioned box **26**. The glue only is applied to the apices of the downward corrugations formed in the grooves of the grooved plate. The smooth covering paper arrives over a roller **35***a* and is applied to the said under face by the lower one of a pair of cooperating rollers **37** between which the previously assembled sheets advance to the right. If the paper run **32** consists of transversely corrugated paper with a smooth top sheet, the assembled material **38** leaving the pair of rollers **37** is a stiff "double-double board" consisting of two corrugated layers having their corrugations running at right angles, with both faces of the board covered by a smooth sheet. This "double-double board" then proceeds to drying and cooling devices not shown in the drawing, whereupon it is ready for cutting to panels of desired length or size.

The pair of rollers **37** is driven by suitable means not shown and is the main device for drawing the various runs of papers through the machine; other advancing means such as the rollers **3** and the belt **34***a* if driven serve mainly to relieve the paper run or runs in question of excessive or otherwise undesirable stresses.

What I claim is:

1. An apparatus for providing a continuous web of material with longitudinal corrugations, comprising a stationary plate having parallel longitudinal grooves, a series of indeformable forming members engaging said grooves of said stationary plate at longitudinally and laterally offset points for pressing said web into said grooves as said web is advanced through said points so that said web is pressed first into a central groove of said plate and thereafter in succession into one adjacent lateral groove after the other at both sides of said central groove.

2. An apparatus for providing a continuous web of material with longitudinal corrugations, comprising a stationary plate having parallel longitudinal grooves, a stationary supporting frame, a number of transverse shafts supported in said frame parallel to said stationary plate at right angles to said longitudinal grooves thereof, at least one indeformable rotatable forming roller mounted on each of said shafts in peripheral engagement with one of said grooves for pressing said web into said groove as said web is advanced over said plate in a direction parallel to said grooves, the said rollers being laterally offset with respect to each other so that a roller mounted on the first of said shafts engages a central groove of the said stationary plate and each of the rollers mounted on the remaining shafts engages another groove adjacent to that first engaged by a roller mounted on the preceding shaft, the points of first engagement a roller into each of said grooves thus forming a wedge pattern.

3. An apparatus as claimed in claim 1 in which the said stationary plate is heatable and in which the said rollers are laterally displaceable on their respective shafts to remain in engagement with their respective grooves of the stationary plate as the latter expands or contracts laterally.

4. An apparatus for providing a continuous web of material with longitudinal corrugations, comprising a stationary plate having parallel longitudinal grooves, a stationary supporting frame, a plurality of indeformable shoes mounted on said frame each engaging one of said grooves of said stationary plate for pressing said web into said grooves as said web is advanced over said plate in a direction parallel to said grooves, the said shoes being longitudinally and laterally offset with respect to each other in a wedge pattern, the foremost of said shoes engaging a central groove of the said stationary plate and each of the remaining shoes engaging another groove adjacent to that engaged by a shoe with respect to which it is longitudinally offset to the rear.

5. An apparatus as claimed in claim 4 in which the said stationary plate is heatable and in which the said shoes are laterally displaceable on said frame to remain

in engagement with the respective grooves of the stationary plate as the latter expands or contracts laterally.

6. An apparatus as claimed in claim 4 in which said stationary frame is swingably connected to said stationary plate so as to permit swinging the said shoes out of engagement with their respective grooves of the stationary plate.

7. An apparatus as claimed in claim 4 in which said stationary frame comprises a plurality of shoe-carrying parts articulated to each other and provided with cooperating abutments limiting their relative angular displacement, one of these shoe-carrying parts being swingably connected to said stationary plate, and each of the said shoe-carrying parts carrying a group of the said shoes.

8. An apparatus for providing a continuous web of material with longitudinal corrugations comprising a stationary plate having parallel longitudinal grooves separated by longitudinal ridges, a plurality of indeformable forming shoes of longitudinally variable cross-section each engaging one of said grooves between said ridges for pressing said web into said grooves as said web is advanced longitudinally over said plate, the said shoes being longitudinally and laterally offset with respect to each other in a wedge pattern, the foremost of said shoes engaging a central groove of the said stationary plate and each ridge engaged on its inner side by one of the said shoes being engaged on its outer side by the front portion of the next rearwardly offset shoe, the rear portion of the latter also engaging the inner side of the ridge outwardly adjacent to the ridge engaged on its outer side by the said front portion of the same shoe.

9. An apparatus for providing a continuous web of material with longitudinal corrugations, comprising a stationary plate, a plurality of folding rods mounted longitudinally and parallel to each other on said plate to provide longitudinal grooves on the latter between them, the forward ends of said rods being tapered and longitudinally offset with respect to each other in a wedge pattern, a plurality of indeformable forming shoes each engaging one of said grooves between adjacent rods for pressing said web into said groove as said web is advanced over said plate longitudinally of said rods, the said shoes being longitudinally and laterally offset with respect to each other in a wedge pattern, the foremost of said shoes engaging the groove between adjacent central rods and each rod engaged on its inner side by one of the said shoes being engaged on its outer side by the front portion of the next rearwardly offset shoe, the rear portion of the latter also engaging the inner side of the rod outwardly adjacent to the rod engaged on its outer side by the said front portion of the same shoe.

10. An apparatus for providing a continuous web of material with longitudinal corrugations, comprising a stationary plate having parallel longitudinal grooves, longitudinal guiding means extending parallel to said stationary plate, a movable support slidably mounted on said guiding means, means for reciprocating said movable support along said guiding means, a plurality of forming members mounted on said movable support for pressing said web into said grooves of said stationary plate as said movable support is displaced in one direction over said plate, the said forming members being longitudinally and laterally offset with respect to each other in a wedge pattern pointing in the said one direction, the foremost of said forming members engaging a central groove of the said stationary plate and each of the remaining forming members engaging another groove adjacent to that engaged by a forming member with respect to which it is longitudinally offset to the rear.

11. An apparatus for providing a continuous web of material with longitudinal corrugations, comprising a stationary plate having parallel longitudinal grooves, a series of forming members engaging said grooves of said stationary plate at longitudinally and laterally offset points for pressing said web into said grooves as said web is advanced through said points so that said web is pressed first into a central groove of said plate and thereafter in succession into one adjacent lateral groove after the other at both sides of said central groove, and means cooperating with said stationary plate in a region of the latter situated at the rear of said forming members in the direction of advancement of said web, for applying and bonding to the latter at least one other web of smooth material whereby corrugations provided in the first said web are conserved.

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