The present invention relates to the stitchless tubular container and the stitchless box container and the method and the apparatus for manufacturing the same, which containers are produced from material strips by the successive process which comprises the step of making a tubular body, whereby the corrugated strips with their flutes obliquely or longitudinally flowed in the axial direction are superposed on the liner strips, the adjacent edges of adjacent convolutions thereof are overlapped each other, the step of making longitudinal creases on the tubular body, the step of gradually flattening the tubular body thus obtained and finally severing said flat tubular body into individual corrugated containers.

4 Claims, 49 Drawing Figures
CORRUGATED CONTAINER AND METHOD AND APPARATUS FOR MANUFACTURING THE SAME

This invention relates to a method and apparatus for making a so-called corrugated cardboard tubular body from one corrugated strip lined with two plain strips on each side thereof, more particularly to a method and apparatus to provide such a tubular body with creases, slots, etc. and severing it into individual corrugated containers on continuous basis, without the loss of materials.

In the prior art of making the cardboard blanks, it has been general practice that first the plain liners from mill roll stands are combined with a strip supplied from the other mill roll stand and provided with corrugations thereon, next the combined web is passed through a heater and then is cut in the uniform length by a corrugator into individual plain cardboards, which are finally made into folded corrugated cardboard containers after passing through the creasing, folding and other processes.

According to the above method, some eight percent of material strips is wasted in producing cardboards and the waste percentage increases further to at least 30 percent for producing final corrugated cardboard containers. Referring to the machine installation area in a factory, the length from 50 m to 100 m is needed to set up a corrugator and the width from 15 m to 30 m is needed to make the finished corrugated cardboard containers from the corrugated cardboards. Besides the corrugator, such devices as a rotary slitter, a rotary slotter, a printing slotter, a belt feed folder gluer, a folder gluer, a folder stitcher, other stitchers, a rotary die cutter, an auto-stacker, etc. are arranged in the factory and the corrugated cardboards are carried to each of them for the required processing.

In the case where the factory is equipped with one corrugator for making only one kind of cardboard blanks of a certain size, at least the following labor force is needed for a single shift operation.

Operator for the corrugator: 3
Operator for supplying the corrugator with strips: 1
Examiner at the corrugator: 2
Printer and glue point: 3
Examiner and bundler of the cardboard blanks: 1
Supervisor of the factory: 1
Total: 11

However, in view of the fact that the corrugated cardboard production capacity of a corrugator has recently reached the level of 100 - 200 m/minute and various kinds of corrugated cardboards are produced from the corrugator, actual labor force required would be several times as much as the above-mentioned labor force.

As mentioned heretofore, the prior art involves much loss of material strips, which, coupled with the requirement of much labor, will result in low economy. Furthermore, since the prior art is to corrugate a medium strip in cross direction, it has a disadvantage in that strips are low in strength. In order to eliminate such faults, a technique to corrugate a medium strip in machine direction has recently been studied. According to this new technique, compressive strength of corrugated strips in machine (longitudinal) direction will be raised by some 50 percent and the production speed will also increase. However, this technique involves a disadvantage that the compressive strength in cross direction is lowered. Although this technique increases the strength of corrugated strips, in this invention it is known in the field of the air-cell pipe cover of helically wound core, but not in the field of the cardboard containers. This invention relates to the paper board corrugated container and the method to produce it taking advantages of the cardboard which absorbs moisture at the stage of applying adhesive stretches and shrinks at the stage of drying and so, it, 2,978,373 uninterrupted a medium strip in machine direction has recently been studied. According to this new technique, compressive strength of corrugated strips in machine (longitudinal) direction will be raised by some 50 percent and the production speed will also increase. However, this technique involves a disadvantage that the compressive strength in cross direction is lowered. Although this technique increases the strength of corrugated strips, the decreases in the material loss and labor force cannot be expected from it.

The technique of the helically winding of corrugated strips, similar to that in this invention is known in the field of the air-cell pipe cover or helically wound core, but not in the field of the cardboard containers. This invention relates to the paper board corrugated container and the method to produce it taking advantages of the cardboard which absorbs moisture at the stage of applying adhesive stretches and shrinks at the stage of drying and so, has no relation to the producing of the following asbestos air-cell pipe covering. For example, U.S. Pat. No. 2,978,373 has disclosed the method in which tubes for insulation purposes are manufactured by winding a corrugated strip helically around a mandrel. This U.S. Patent relates to an air-cell, insulating, pipe covering comprising a helically wound strip of corrugated material forming a tube and having its corrugations extending at an oblique angle to the longitudinal axis of the tube, the land portions only of the corrugations being continuous and uninterrupted throughout the width of the strip with the outwardly facing lands thereof progressively wider and flatter toward the edges of the strip than at the center of the strip, and with the inwardly facing lands thereof progressively wider and flatter toward the center of the strip than at the edge of the strip, whereby the obliquely positioned lands are in effect curved to conform substantially to the curvature of a cylindrical surface concentric to the axis of said tube. The present invention is different from the quoted invention in that the latter aims at producing corrugated asbestos air-cell pipe covering with less adhesive, hence lighter in weight and cheaper in cost but without any substantial sacrifice in strength.

The present invention is based on a unique idea that a stitchless corrugated container is manufactured by combining and making liners and a corrugated strip into a tubular body, which is then made into folded corrugated containers of high strength on continuous basis, without the loss of materials and with less labor force. The folded corrugated container obtained according to the present invention, if it is unfolded, takes the shape of either the tubular body or the box. An object of the present invention is to manufacture stitchless corrugated tubes on continuous basis.

Another object of the present invention is to manufacture corrugated tubes on continuous basis, wherein liners and a corrugated strip is supplied onto the rotating mandrel, helically in relation to the center of axis.
of the mandrel, and they are overlapped helically by inserting a corrugation in the leading corrugation of a corrugated strip.

A further object of the present invention is to manufacture corrugated tubes on continuous basis, wherein liners and a corrugated strip are supplied axially onto the fixed mandrel and they are gradually made into semi-cylindrical bodies and two of such semi-cylindrical bodies are combined together.

A still further object of the present invention is to manufacture folded stitchless corrugated containers which can easily be unfolded into tubular bodies from stitchless corrugated tubes.

Other object of the present invention is to provide stitchless corrugated containers of folded corrugated cardboard which can easily be unfolded into the box-shape, by adding the slotting and transverse-creasing processes to the manufacturing process of containers which can easily be unfolded into a tubular body.

A further object of the present invention is to provide a method and apparatus for manufacturing folded stitchless corrugated containers at a stroke, by making stitchless corrugated tubes continuously, giving them longitudinal creases, transforming them gradually into flat shape and cutting them off.

A still further object of the present invention is to provide a method and apparatus for manufacturing folded stitchless corrugated containers on continuous basis and at a stroke, by making stitchless corrugated tubes continuously, giving them longitudinal creases and slots, transforming them gradually into flat shape and giving them transverse creases and cutting them off.

Technical terms given in this specification of the present invention are defined as follows:

“Corrugated tube” means a tube formed by combining liners and an interior corrugated strip on the mandrel and also the material of corrugated containers in process of the longitudinal creasing, flattening and severing.

“Folded corrugated container (B)” means the above-mentioned tube which has passed the slotting, transverse creasing and severing processes and which can easily be made into the box-shape.

“Folded corrugated container (T)” means the above-mentioned tube which has passed the severing process and which can easily be unfolded into the tubular shape.

The nature and advantages of this invention will be described in greater detail in conjunction with the attached drawings in which:

FIG. 1 is a plan view showing the apparatus, using a rotative type mandrel, of this invention as a whole.
FIG. 2 is a front view showing a portion, partly broken away, of the apparatus in FIG. 1.
FIG. 3 shows the arrangement of a mill roll stand, etc. to feed the first and the third liners.
FIG. 4 shows the arrangement of a mill roll stand, etc., to supply the second or corrugated strip.
FIG. 5 is an enlarged perspective view of an end portion of a corrugating roll.
FIG. 6 is a plan view showing the forms of the both ends of the corrugating roll.
FIG. 7 is a side view, in section, of a weighting device at a portion where a corrugated strip is wound helically about a mandrel.
FIG. 8 is a sectional view of a terminal end portion of the mandrel.
FIG. 9 and FIG. 10 are a plan view and a front view, respectively, of the mandrel.
FIG. 11 is a front view, partly in section, of the connected portion of the mandrel.
FIG. 12 is a cross section of the part of the corrugated strips compressing device taken on line 12—12 in FIG. 2.
FIG. 13 is a front view of the corrugated strips compressive device.
FIG. 14 is a side view of the part of the longitudinal creasing device, taken on line 14—14 in FIG. 2.
FIG. 15 and FIG. 16 show a stamping device in a side and a front elevation, respectively, of a portion of the device in FIG. 14.
FIG. 17 shows a front view, in section, of the feeding device of the corrugated tube.
FIG. 18 is a cross section of the part of the corrugated tubes feeding device, taken on line 18—18 in FIG. 2.
FIG. 19 is a cross-section of the part of the longitudinal-creasing device, taken on line 19—19 in FIG. 2.
FIG. 20 is a front view of a portion of the slitter.
FIG. 21 is a diagram showing the principle of the printing device.
FIG. 22 is a cross-section of the part of the printing device, taken on line 22—22 in FIG. 2.
FIG. 23 is a cross-section of the part of the transverse-creasing device, taken on line 23—23 in FIG. 2.
FIG. 24 is a partial front elevation of the transverse-creasing device.
FIG. 25 is a cross-section of the part of the transverse-creasing device, taken on line 25—25 in FIG. 2.
FIG. 26 is a front view of the severing device.
FIG. 27 and FIG. 28 are a front view and a plan view, respectively, of the device to regulate the angle at which strips are supplied onto the mandrel.
FIG. 29 is a diagram showing the liner edge control device.
FIG. 30 is a plan view of a corrugated tube as compressed into a plain board.
FIG. 31 is a plan view of the part where longitudinally corrugated tubes are manufactured.
FIG. 32 is a front view of the part shown in FIG. 31.
FIG. 33 is a perspective view, on an enlarged scale, of the part enclosed with a chain-line circle in FIG. 32.
FIG. 34 is a diagram showing, in (a) and (b), processes according to the present invention, and in (c), the section of the mandrel at each process.
FIG. 35 is a perspective view of the box, partly broken away, formed by setting up a folded corrugated container (B) of the embodiment 1. longitudinal-creasing.
FIG. 36 is a perspective view of a corrugated tube of angular cross-section formed by winding liners and a strip around the mandrel and processed as shown in FIG. 2.
FIG. 37 is an enlarged view of the part enclosed with a chain-line circle in FIG. 36.
FIG. 38 is an enlarged view of the part enclosed with a chain-line circle in FIG. 36.
FIG. 39 is a perspective view of a folded corrugated container (B) at the final process as shown in FIG. 2.
FIG. 40 is a cross-section of the corrugated tube of the embodiment 2.
FIG. 41 is an enlarged view of the part enclosed with a chain-line circle in FIG. 40.

FIG. 42 is a perspective view of the conventional corrugated container.

FIG. 43 is a side elevation of the conventional corrugated container.

FIG. 44 is a cross-sectional view, partly broken away, of the part taken on line 44—44 in FIG. 43.

FIG. 45 is a perspective view, partly broken away, of a folded corrugated container (T) of the embodiment as it is set up into a tubular body.

FIG. 46 is an enlarged view of the part enclosed with a chain-line circle in FIG. 45.

FIG. 47 is a perspective view of the corrugated container (T) as it has been longitudinally creased, flattened and cut off.

FIG. 48 is a cross-section of the tubular corrugated cardboard of the embodiment.

FIG. 49 is an enlarged view of the part enclosed with a chain-line circle in FIG. 48.

An example of the processing according to the present invention is outlined below, with reference to FIG. 34(a) and FIG. 34(b).

A corrugated tube 118 made by a corrugator 119, either a rotative mandrel system or a semi-circular system, is supplied by a corrugated tube feeding device 129 to a longitudinal-creasing device 128, where it is given longitudinal creases. In the case where it is made up into a corrugated tubular container, it is gradually flattened by processes shown in FIG. 34(a) and is set to a severing device 134 (passing through a printing device 132, where necessary) to be made into individual corrugated containers (T) 332. These folded corrugated containers (T) can easily be set up into tubular corrugated containers 325.

In the case where box-shape corrugated containers are made, a corrugated tube 118 which has been given longitudinal creases according to the processes shown by FIG. 34(b) is sent to a slotting device 130, where it is given slots, is given transverse creases by a transverse-creasing device 133 (passing through a printing device, where necessary), and is severed by a severing device 134 into individual folded corrugated containers (B) 317. These folded corrugated containers can easily be set up into box-shape corrugated containers 323.

FIG. 34(c) shows cross-sections of corrugated tubes at each process.

A description is made below of embodiments of the present invention, in which corrugated tubes and corrugated containers are manufactured by winding helically liners and corrugated strips onto a mandrel, with reference to the attached drawings.

Numeral 120 indicates a hollow winding mandrel with a tubular body 120a connected by a connector 120b and carrying at its one end a shaft 121 which is supported by a bearing 122. Secured to the end portion of the mandrel 120 is a gear 123, with which a small gear 124 is engaged. Said small gear 124 is connected to a main driving device 125.

Toward the extreme end of the mandrel 120 (leftwards in FIG. 1), a group of liner supplying devices, i.e., 126A, 126B and 126C for supplying the first strip, the second one and the third one respectively are arranged in the order given, which are followed by a series of tubes, i.e., a device 128 to put weight on the web, a device 128 to make longitudinal creases, a device 129 to feed corrugated tubes, a device 130 to make slots, a device 131 to supply power, a device 132 to print, a device 133 to make transverse creases, a device 134 to sever, a device 135 to guide and a device 136 to stack.

The strips embodied in this invention are the same as those in the conventional manufacturing art of cardboard blanks, wherein the first and the third supply rolls 126A and 126C respectively supply the plain strips onto the winding mandrel 120 and the second supply roll 126B supplies the strip with the forming of corrugations onto the mandrel.

As can be seen from FIG. 3, the liner 150 is drawn out from a mill roll stand 151, is passed through a pre-heater 152 and a preconditioner 153 to be heated and humidified, and then supplied onto the mandrel 120.

The second supply roll supplies the interior strip formed with corrugations onto the mandrel 120. As indicated by FIG. 4, the interior strip drawn out from one of the mill roll stands 151 is heated and humidified by a steamer 154, is fed between an upper and a lower rolls 155a and 155b respectively, is supplied with adhesive by an adhesive applicator roll 156 and is supplied onto the mandrel 120.

The adhesive applicator roll 156 is attached with a scraper, a cleaning ring, etc., as well as a doctor roll and a adhesive tank and they all help to ensure the stability and the uniformity of the adhesive applied to the interior strip 159. This adhesive application technique is well known and the detailed description of it is not made here.

The upper roll 155a and the lower roll 155b are different from corresponding rolls in the prior art. In the prior art, both the upper roll and the lower roll is of spur gear-like type with convexes and concaves, both of the same curvature, in alternate order. Therefore, corrugated strips made by conventional corrugated rolls have uniform convexes and concaves. Because of this uniformity, it is necessary to deform convexes or concaves of the corrugated strips for overlapping convexes and concaves of the same curvature. Whereas, according to the present invention, as shown by FIG. 6, corrugated rolls are designed in such a fashion that if the right end of a certain convex is smaller in curvature, the opposing left end of the convex is larger in curvature but adjoining concaves have a larger curvature at the right end and a smaller curvature at the left end. As shown in FIG. 5, the corrugated form at the roller surface shows at the extreme end portion a concave of a larger radius (r') of curvature and a convex of a smaller radius (r'') of curvature alternately on the pitch circle 160. For example, in the case where the lower roll 155b is shown as the corrugation indicated by FIG. 5, the upper roll 155 shows corrugation having concaves and convexes opposing to convexes and concaves, respectively, of the lower roll.

The reason why variations are made in the corrugation of corrugated rolls is to attain easy overlapping of corrugated strips on the mandrel 120 by making changes in the curvature of concave and convex at both ends, without deforming convexes or concaves of the corrugated strips.

A device for compressing the interior strip 138 illustrated in FIG. 7 compresses the interior strip 159 successively as it is wound on the mandrel 120 so as to continue the winding. This device comprises an endless belt 161 having the width larger than that of the interior strip 159, and is rotated by a driving roll.
in the direction of an arrow 163, the same direction as an arrow 162 showing the advancing direction of the interior strip, and is carried on a driven roll 165 which compresses the interior strip 159 as it is pulled by a spring 166.

A supply steam pipe joint 139 and a drain pipe joint 140 are connected to one end of the mandrel 120.

The arrangement illustrated in FIG. 8, comprises a shaft 121 which is connected to the mandrel 120 and passes through an end plate 169 fixed in the end portion of a pipe 168, an outer pipe for supply steam 170 and an inner pipe 171 for exhaust steam. The outer pipe 170 and the inner pipe 171 are fixed integrally within the pipe 168 and are rotated by the mandrel 120 so that the supply steam joint 139 and the drain pipe joint 140 work as the rotatable joints. Seal materials 175 and 176 are applied to inner walls 173 and 174 of a casing 172 so as to maintain the airtightness of the peripheries of the outer pipe 170 and the inner pipe 171. The drain pipe joint 140 comprises a fixed casing 178 connected to an end 177 of the inner pipe 171 and a drain pipe 179 connected thereto.

Following the above-mentioned at the end of the mandrel 120, the part 180 to promote winding is established, which part carrying successively such devices as 181, 182, 183, 184 and 185, for making longitudinal creases, for feeding corrugated tubes, for making slots, for modifying said corrugated tubes and for compressing said corrugated tubes into flat forms respectively. The form of the mandrel in these portions changes from a rather round and rectangular shape gradually to a flat one.

The mandrel 120 carries a heating device therein. The electric heater or the steam heater 141 is used to heat the mandrel at the desired temperature at each portion ranging from the starting end to the feeding device for corrugated tubes. In the case of the former, a proper heater can be arranged at each portion, while in the case of the latter, economical heating can be obtained. The embodiment shows the construction of the latter.

The heater 141 comprises a helical pipe 186 and a center pipe 187, which are communicated with each other at their terminal end. The starting end of the helical pipe 186 is communicated with the outer supply steam pipe 170 and the center pipe 187 is communicated with the drain pipe 179.

The strip weighting device 127 (refer to FIG. 12 and FIG. 13) is arranged oppositely to the winding part 180 of the mandrel 120 and comprises suppressing rolls 191 pivoted rotatably with the lower end of curved rod 190 which is suspended rotatably by a pivot 189 fixed to the upper portion of the frame 188 so that said rolls may give the uniform suppression constantly on the mandrel 120.

A frame 142 (refer to FIG. 14) carries therein all of the devices hereinafter mentioned and causes each of them to rotate cooperatively in the same direction as the mandrel 120, wherein a rotatable drum 195 is inserted rotatably in a circular rail 193 by a plurality of rolls 194, to which each of the following device is attached.

The device 128 (refer to FIG. 14, FIG. 15 and FIG. 16) is to make longitudinal creases axially on the four corners of the corrugated tubes, wherein vibratory beating devices are secured against the mandrel 120 in the inner surface of the above-mentioned rotatable drum 195. Supports 196 are clamped by bolts 198 to motor stands 197 for regulating the location of the radius of the rotatable drum. Vibrating motors 199 are fixed to said motor stands 197. Beating plate 202 are connected between the ends of vibrating rods 200 connected to said motors and the ends of fixed rods 201 extended from one side of the motor stands 197. A spring 203 is interposed between the lower end of said rod 200 and the motor stand 197. The beating plate 202 is vibrated by the rotation of the vibrating motor 199.

The corrugated tube feeding device 129 (refer to FIG. 17 and FIG. 18) is provided in the rotatable drum 195 within the frame 142. Magnetic endless belts 204 are spread between a driving roller 205 and a driven roller 206. These two rollers are mounted on a supporting shaft 208 against a support 207. The driven roller 206 is pulled by an adjusting bolt 209 and fixed to the support 207 by regulating the tension of the magnetic endless belt 204. The driving rollers 205 transmit the power successively from the motor 211, by bevel gears 210 engaged with the shaft 208 for the mutual rotation. Numerical 212 indicates tension rollers in the magnetic endless belt 204. The driving rollers 205 transmit the rotation of the motor to the rotatable drum 195 engaged with gear 216 fixed to said rotatable drum 195.

The device 130 for making slots (refer to FIG. 19 and FIG. 20) is provided in the rotatable drum 195 inside the frame 142, similarly to the above devices, and makes slots axially on the flattened blanks. Grooved rolls 217 are supported rotatably by a supporting shaft 218 in the four corners of the mandrel 120. Roll-shaped knives 219 are supported by a supporting shaft 221 secured to the support 220 fixed to rotatable drum 195.

Said supporting shafts are cooperated with each other by the medium of universal joints 222 and intermediate shafts 223 and share the rotation by the motor transmitting devices of bevel gears 224 and 225 and the interlocking shaft 226. Numerical 227 indicates the blade of the roll-shaped knife 219.

The printing device 132 (refer to FIG. 21 and FIG. 22) is provided in the rotatable drum 195 in the frame 142, similarly to the former devices, and print from both sides or from one side on corrugated tubes. Two devices, adopting the printing principle usually called the aniline printing (flexographic printing system) are set up oppositely, because by this system printing is effected with less pressure on the plate. A conduit pipe 233 and an ink pump 234 are interposed between an ink tank 231 storing the dry-type ink and an ink-pad 252 filled with sponge or the like. A doctor roll 235 is contacted with said ink-pad 232, and a rubber plate 238 on a die cylinder 237 is connected with an anilox roll 236, said plate being arranged in touch with the corrugated web on which printing is given. The above rolls are supported on the shaft threaded in the supporting plate 239 in such a manner that gears 241 are engaged with one end portion of the shaft 240 in the die cylinder 237, while bevel gears 242 are engaged with the other end portion of the shaft 240 and bevel gears 243 are engaged with said bevel gears 242. These gears are driven by motive power from the motor and the re-
duction gear attached to the rotatable drum 195 (these movements are not shown in the drawings). Numeral 244 indicates a cover. The device 133 to make the transverse creases (refer to FIG. 23 and FIG. 24) is provided in the rotatable drum 195 in the frame 142, similarly to the former devices, and makes creases on the cardboard blanks so as to make the top and bottom flap portions. Two rolls 246 of the same radius to make the creases are provided oppositely to the supporting plate 245, each of which being attached to the rotatable drum 195. These rolls are supported on the shaft 247 by the medium of springs 248 at both ends of the upper and the lower shafts 247 and each of the two rolls is built in the general direction of the axis with the projected creaser. The creasing is promoted by the blade 249 facing each other once in each rotation of the rolls 246, said rotation is given by a pair of timing gears 250 engaged with each other at one end of the upper and the lower shafts 247, and bevel gears 251a and 251b cooperate with the driving device.

The severing device 134 (refer to FIG. 25 and FIG. 26) is provided in the rotatable drum 195 in the frame 142, similarly to the former devices, and sever the cardboard blanks into the uniform length. Two guiding plates 253 are fixed to the struts 252 built symmetrically in the rotatable drum 195, and severing knives 254 are inserted within grooves 255 so as to move disjunctively. The severing knives move outwards constantly by the spring 257a inserted in the movable piece 258 in solenoids 257 to which each of the edges of arms 256 projecting from both edges of the severing knives 254 connects.

The guiding device 135 (refer to FIG. 1 and FIG. 2) is provided in the rotatable drum 195 in the frame 142, similarly to the former devices, and guides the severed cardboard blanks to the succeeding stacking device. This arrangement is composed of a pair of boxes 261, each having at its top one guiding plate 260 which is opposed to each other and forms an opening 259 for the blanks.

The stacking device 136 (refer to FIG. 1 and FIG. 2) stacks the folded corrugated containers sent from the guiding device 135 and comprises an inlet 262, a sliding plate 263 and an outlet 264.

The liner supplying angle regulating device (refer to FIG. 27 and FIG. 28) regulates the angle at which liners are supplied to the mandrel 120 and it comprises a mill roll stand 151 mounted on a base 266 on a bed 265, a pin 267 threaded in the bed 265 to rotate the base, a screw rod 269 with one end thereof being fixed in a bearing 268 beside the bed 265, and a nut 270 in said screw rod and attached to the base 266 to regulate the angle of the strips for the mandrel 120.

The liner edge control device (refer to FIG. 29) controls the location of the edges of liners 150 at which they are supplied to the mandrel 120.

A detector of the edges 272 persues the edges of liners according to the signal from the electrical persuing system 273 and 274. A transmitter 275 of the detected location gives the analogue signal of the edges to the amplifier 276. The signal amplified by said amplifier is transmitted to an oil pressure control valve 277 driving a slitter cylinder 178. The movement of the cylinder is observed by a transmitter 279 of location and the signal observed is made the feedback to the amplifier, whereupon the signal is compared with that of the transmitter and modified. Numeral 280 indicates a generator and numeral 281 indicates an automatic or manual switch.

Referring now to the operation of the above-mentioned apparatus, FIGS. 1 – 4 show a rough construction of the apparatus according to the present invention, in which the operation procedures are shown as follows.

The first paper strip on the mill roll stand 151 is preheated and humidified by a conventional preheater 152, and then it is wound about the winding mandrel 120, after its end being fixed temporarily to the slowly rotating mandrel. On the other hand, second paper strip on the second mill roll stand, after being humidified by a conventional pre-conditioner 153, is corrugated passing through between the upper corrugating roller 155a and the lower corrugating roller 155b. The paper strip thus corrugated, after passing through the adhesive applicator roll 156, is laid by degrees over the rotarily advancing dirt liner 150. The third paper strip on the third mill roll stand is similarly pre-heated and humidified and is laid over the corrugated strip rotarily advancing with the first liner. Thus a single-faced corrugated board is continuously manufactured in the first part of the present machine.

In order to give easiness of combining and to obtain good adherence by the nip-pressure adding treatment, using a weighting device 127 provided with a plurality of rolls 191 as is shown in FIG. 12 and FIG. 13, the winding mandrel 120 is designed to have cross section of somewhat round shape as shown in FIG. 7. The winding mandrel, however, changes in shape and loses its roundness at the stage of the heater 141, and then is changed into flat shape at the stage of the printing device 132.

The tube 118 which has been given nip-pressure is conveyed to the longitudinal-creasing section which consists of a vibration motor 199, a beating plate 202 and a fixed rod 201. The tube which has been given longitudinal creases correctly by the above apparatus is then conveyed to a feeding device provided with a heater. The above-mentioned operations are preparatory processes mainly done by hand. The guiding method by means of machine operation could be applied to the foregoing processes.

The apparatus mentioned below have respectively a device for pushing forward the tube structurally. Accordingly, when the present machine works at a normal speed, the tube 118 is rolled up and made incessantly. In the heating section shown in FIG. 17 and FIG. 18, the outer board of the winding mandrel 120 is heated with dry-steam of proper temperature conveyed from the boiler (not shown in the drawings) through the casing 172 and the inner pipe 171. The rotating of a motor 211 is transmitted to the driving roller 205, and so the circulating magnetic endless belt 204 driven by this roller 205, owing to its absorption pressure and conveying function, sends out the tube which has been finished with perfect adhesion and desiccation.

The magnetic endless belt 204 shown in FIG. 17 can be regulated by the regulating bolt 209, and its supporting tension rollers 212 smooth conveying of the tube 118.

The tube 118 is then pushed forward to the slotting device 120. This device, as is shown in FIG. 19 and FIG. 20, consists of a grooved roll 217 provided inside of the winding mandrel 120 to engage with the rolling cutter on a roller having the roll-shaped knife 219. The
slotting device is provided on the support 220 at four diagonal places on the rotating drum 195. On this stage the tube 118 is supplied with slots in the shape shown in FIG. 30, and in the following severing device, it is severed along the dotted line X.

The tube 118 which has been given needed slots is gradually made flat, parallelising with transfiguration of the winding mandrel 120, and is pushed forward to the section of the printing device 132. In this section, two sets of printing device are provided for work efficiency, and the tube is printed on both sides at a stroke as it is held between the two sets as shown in FIG. 21 and FIG. 22. The rotating drum 195 supported by the rollers 194 suitably provided on the circular rail 193 on the frame 142, is always rotating with various working devices on its inner side, because rotation of the main driving device 125 (shown in FIG. 2) is transmitted to the slotting device 183. Therefore, supply of ink is done by stuffing liquid absorbing material like sponge into the ink tank 231 and spreading the ink over the die cylinder 237 for the purpose of preventing the ink from spilling when the ink tank is turned upside down according to the rotation of the drum.

The tube suitable printed with quick-drying ink is then pushed out to the succeeding section, where the tube is given transverse creases needed for flap and bottom making. The present machine, different from the conventional way of crease making of corrugated board, employs a creasing device, shown in FIGS. 23 and 24, which comprises a reeling roll 246 having a creasing blade 249 and a spring 248, to give transverse creases to the folded tube 118.

The tube 118 to which transverse creases have been thus given, is then conveyed to the severing apparatus 134 and is cut off at the point of the prescribed length, for example, along the dotted line X in FIG. 30. The cut-off corrugated containers B, passing through the guiding device 135, fall on the stacking device 136.

As to the guiding device 135, detailed illustration is omitted here, as a flat passage as required for the guiding apparatus is easy to design for a man of experience in this field.

In the above example can be in eve-numbered polygonal shape (for example, sexangle and octagon).

Hereinafter disclosed is the method and the apparatus to make a longitudinally fluted container, as described in FIG. 32 and FIG. 33, from the longitudinally corrugated tubular body 316. The first liner strips 150c and 150d are supplied from the mill roll stands 151c and 151d which are arranged at the both sides of the winding mandrel 284 having the same section as the winding mandrel 120, in such a manner that the liner strips are bent inwardly to conform to said mandrel and to form an overlapped portion at the end thereof by the guiding rollers 285a and 285b, while the liner strip 150c is put inside of the liner strip 150d. These two liner strips are combined to each other with adhesive applied to the surface of the edges of said strip 150d by the adhesive applicator roll 286. The tubular body formed by the above process is supplied with adhesive to the overall outer surface thereof by the adhesive applicator rolls 287a and 287b, while moving leftwards in FIG. 31.

The corrugated medium strips 159c and 159d formed with longitudinal corrugations 292, as in FIG. 33, are supplied from the mill roll stand positioned vertically in relation to that supplying the first liner strips in order to make thick the overlapped portions and the two corrugate strips are bent inwardly of guiding roller 288a and 288b to conform to said mandrel so as to be superposed on the first liner strips, whereby adhesive is applied to the inside of the edge portions of the strip 159c by the adhesive applicator roll 289 and said edge portions of the strip 159c is overlapped by the edges of the strip 159d, whereby the strips 159c and 159d are secured to the first liner strips 150c and 150d with adhesive applied to the outer surface thereof. The tubular body made by the above process is supplied with adhesive on the surface thereof by the adhesive applicator rolls 293a and 293b of the adhesive applicator 290.

The flutes of the corrugated medium strips 159c and 159d are formed in the flow direction of the strips so that the strips are yieldable in the direction opposite to the flow and also easily secured to the first liner strips.

The third liner strips 150e and 150f, supplied from the mill roll stand 151e and 151f are bent to conform to the mandrel by the guiding roller 294a and 294b, are secured to the lower strips having the adhesive applied from the adhesive applicator roll 295 and compressed by the pressure given by the pressure changing roller 291a and 291b, whereby the corrugated tubular body 316 is configured.

The tubular body is then heated by a heater provided in the mandrel 284 as described in FIG. 8.

The apparatus to make the longitudinally fluted container comprises the same as that to make the obliquely fluted container, except that the mandrel is fixed.

The tubular body made by the above processes is next subjected to the processes of drying, longitudinally creasing, slotting, transversely creasing, severing, etc. by the same apparatus as the former apparatus to make obliquely fluted container, therefore the detailed descriptions of the processes, ranging from making longitudinal creases to severing into individual containers, are omitted.

The cardboard container in the prior known manufacturing technique is produced by providing the processes of cutting, longitudinally creasing, slotting, stitching, transversely creasing and so on, on the flat board of the so-called corrugated board comprising the corrugated medium sandwiched between two liner strips. The corrugation of the corrugated board 300 is that, as illustrated in FIG. 42, the flutes 304 of the corrugated strip 303 are arranged at a right angle to the direction of an arrow 305. Therefore, the corrugated board is more yielding in the direction of the arrow 305 (longitudinal), than in the vertical direction of said arrow (transverse). In other words, the longitudinal yielding strength and the transverse one are different.

The corrugated board has such a character that the conventional corrugated container 306 is produced by the steps, as illustrated in FIG. 43 and FIG. 44, comprising the making of longitudinal creases 307 on the board, in the longitudinal direction, securing or stitching the end seam portions 308 with adhesive or the stitching devices 309, and the making of transverse creases 310, thereby configuring the flap portions 311 and 312.

The container thus set up is much strengthened, compared with the corrugated board, against the compressive force from the inward and the outward of the container. With high strength in the longitudinal direction, however, the container has such defects that it is not so strong in the transverse direction and it must be connected at the end seam portions 308. The folded card-
board container to be easily set up to a box container or a tubular container without the above-mentioned defects is produced from the method and apparatus hereinafter described with respect to each embodiment.

The first embodiment discloses the box container, the plies of the body of which comprise one corrugated medium with obliquely positioned flutes superposed between two liners. The first liner strip 150a is helically wound into a tubular body, into the innermost surface of said tubular body, with one edge 313 of each convolution being overlapped with adhesive material thereon by 3 mm. over the edge of the preceding convolution. The medium strip 159 formed with successive corrugations is helically wound all the surface of the first liner strip 150a with the edge 314 overlapped each other by a few mm. and adhered to the outside of the first liner strip 150a and the inside of the third liner strip 150b, with supplied adhesive on about both sides of the tops of the flutes. The third liner strip 150b is helically wound on the all surface over the corrugated medium strip 159 in the same manner as winding the first liner strip with the adjacent edges 313 being overlapped each other with adhesive.

In this way, the tubular body 118 is having a rectangular section is formed, wherein the medium strip 159 with corrugations thereon is superposed between the first liner strip 150a and the third liner strip 150b, whereby the two liner strips and the corrugated medium strips are secured tightly with one another with the adhesive.

In this embodiment, the first liner strip 150a and the third liner strip 150b are wound in the same direction in relation to the axis while the corrugated strip 159 is wound in the opposite direction to said two liner strips. In some cases, if desired, the corrugated tubular body can be produced from the three strips all wound helically in the same direction. The method illustrated in FIG. 1 provides tubular bodies with one corrugated strip between two liner strips, but if desired, double wall corrugated tubular bodies can also be produced by providing the second corrugated strip supply device and the fifth liner strip supply device along the winding mandrel 120. The folded box container (B) 317 obtained at the final process, is provided with the longitudinal creases 319 at the body portion 318 and the slots 321 at the flap portion 320. The transverse creases 322 are provided between the body portion 318 and the flap portion 320. Therefore, the folded box container (B) 317 can be set up to a corrugated box container instantly after folding the flap portions 320. 317a illustrates another embodiment of the folded box container.

The second embodiment relates to the box container, the plies of the body of which comprise two corrugated mediums superposed between three liner strips. The tubular body by this embodiment, the section of which is given in FIG. 40, can be obtained by a single process, with addition of he corrugated medium supply device and the fifth liner strip supply device which are similar to those producing the box container 317 in embodiment 1. This method comprises the same steps of winding strips as in the case of embodiment 1, except that a corrugated strip 159a and the third liner strip 150c respectively are superposed outside of the first liner strip 150a and the second liner strip 150b and outside of said strip 159a.

The third embodiment discloses the folded, tubular container (T) which is easily unfolded into the tubular container. It comprises the steps of making longitudinal creases on said container (T) with the obliquely positioned flutes of the corrugated strips, flattening it and severing it by the machine in FIG. 2. Numerals 325 indicates the tubular container comprising the first liner strip 150a helically wound into the innermost surface of layers of said container with the edges 326 being overlapped with one another with the adhesive, the corrugated medium strip 159 formed with corrugations all over with the edges 327 being overlapped with one another by a few mm. and secured to the surface of the first and the third liner strips 150a and 150b applied with the adhesive about the top portions of the flutes of the corrugations, and the third liner strip 150b helically wound over the surface of the corrugated strip 159 in the same manner as winding the first liner strip 150a with the edges being overlapped by the adhesive. Accordingly, the tubular container 325 comprising a corrugated medium strip 159 superposed between the first liner strip 150a and the third liner strip 150b is configured, wherein the liner strips and the corrugated medium strip 150a and 150b and 159 respectively are secured tightly by the adhesive. After winding the above-mentioned strips helically, the longitudinally creases 329 are made on the bulged portion 331, is severed into one folded tubular container (T) 332, as in FIG. 47, which can easily be set up into the tubular container 325 when unfolded. The manner of winding the strip in the third embodiment is, that the third liner strip 150a and the third liner strip 150c are helically wound in the same direction in relation to the axis, while the corrugated medium strip 159 is wound in the opposite direction, although it desired the tubular container comprising these three strips wound helically in the same direction can also be obtained.

The forth embodiment discloses the tubular container comprising two corrugated strips between three liner strips, wherein, as described in FIG. 48, the first liner strip 150a is wound helically into the innermost surface, the corrugated medium strip 159 over the former, the third liner strip 150b over be former, the exterior corrugated medium strip 159a over the former, and finally the fifth liner strip 150c into the outermost surface, are wound helically one by one into a corrugated tubular container with the edges of the convolutions in each strip being overlapped with one another. The corrugated tubular container 333 is produced successively in the form of the folded tubular container (T) comprising the longitudinal creases 334 on it.

The fifth embodiment relates to the folded, box container produced from the longitudinally fluted tubular body. An explanation on this embodiment is made below, in comparison with the conventional art (no drawing is shown). The corrugated tubular body 316 is made by the apparatus shown in FIG. 31 and FIG. 32. Then it is made into individual containers having such external appearance in the first embodiment. The above container, if unfolded and compared with the prior known corrugated box container in FIG. 43 and FIG. 44, has no overlapping at bending portions 308 and requires neither adhesive nor stitching member 309. Thus, it is a stitchless corrugated container. Being free from stitching, this container is much increased in the overall strength, though the strength in the vertical
direction and the horizontal direction is the same as the prior known corrugated container.

The sixth embodiment relates to the folded, corrugated tubular container made from the longitudinally fluted tubular body. The tubular container, when unfolded, has the same external appearance as the container shown in FIG. 36 or FIG. 45, except that the flutes of the corrugated strips 159c, d and the edges thereof are formed parallel to the axial line Y—Y. The folded tubular container produced by this embodiment has the external appearance similar to the folded container shown by FIG. 47.

Although particular embodiments of the invention have been herein disclosed for purposes of illustration and explanation, it is to be understood that modifications and variations will be apparent to those skilled in the art to which the invention pertains and may be made therein without departing from the invention or its scope, which is limited only as defined in the appended claims.

We claim:

1. A method of continuously producing folded, corrugated containers, comprising the steps of supplying to a rotating mandrel at least one liner strip for spirally winding the liner strip on the mandrel with the trailing edge of each spire of the wound strip overlapping the leading edge of the preceding spire, forming at least one corrugated strip having successive concave and convex flutes extending transversely thereof with the flutes having a different radius of curvature at each end thereof with the one ends of successive concave and convex flutes having a larger radius of curvature and a smaller radius of curvature than the other ends of the corresponding flutes having a smaller radius of curvature and a larger radius of curvature, applying adhesive to the thus formed corrugated strip, supplying the corrugated strip to the rotating mandrel for spirally winding the corrugated strip on the mandrel over the liner strip and adhering the corrugated strip to the winding strip, with the trailing edge of each spire of the wound corrugated strip overlapping the leading edge of the preceding spire of the corrugated strip with the larger one ends of the convex flute ends fitting over the smaller convex flute ends, and the smaller concave flute ends fitting into the larger concave flute ends, whereby the liner and corrugated strip are formed as a unit into an endless corrugated tube, forming longitudinal folds or creases in the tube, removing the tube from the mandrel and gradually flattening the tube, and cutting the flattened tube into lengths appropriate for individual containers.

2. A method as claimed in claim 1, further comprising the steps of slotting said corrugated tube at longitudinally spaced intervals and making longitudinally spaced transverse folds or creases in said tube.

3. A method as claimed in claim 1 in which the steps of supplying at least one liner strip comprises supplying two opposed liner strips, one being supplied prior to winding the corrugated strip and the second being supplied for winding over said corrugated strip.

4. A method of continuously producing folded, corrugated containers, comprising the steps of supplying to a rotating mandrel which gradually becomes flatter from one end toward the other at least one liner from a direction oblique to the axis of rotation of the mandrel for spirally winding the liner strip on the mandrel with the trailing edge of each spire of the wound strip overlapping the leading edge of the preceding spire, forming at least one corrugated strip having successive concave and convex flutes extending transversely thereof with the flutes having a different radius of curvature at each end thereof with the one ends of successive concave and convex flutes having a larger radius of curvature and a smaller radius of curvature than the other ends of the corresponding flutes having a smaller radius of curvature and a larger radius of curvature, applying adhesive to the thus formed corrugated strip, supplying the corrugated strip to the rotating mandrel from a point spaced along the mandrel from the supply point of the liner strip and from a direction oblique to the axis of rotation of the mandrel for spirally winding the corrugated strip on the mandrel over the liner strip and adhering the corrugated strip to the winding strip, with the trailing edge of each spire of the wound corrugated strip overlapping the leading edge of the preceding spire of the corrugated strip with the larger one ends of the convex flute ends fitting over the smaller convex flute ends, and the smaller concave flute ends fitting into the larger concave flute ends, whereby the liner and corrugated strip are formed as a unit into an endless corrugated tube, forming longitudinal folds or creases in the tube, feeding the tube along the mandrel toward the flattened end and gradually flattening the tube, and cutting the flattened tube into lengths appropriate for individual containers.