United States Patent [19]

Hayama

[11] **3,919,925**

[45] **Nov. 18, 1975**

[54] **PROCESS AND EQUIPMENT FOR CONTINUOUS MANUFACTURE OF CORRUGATED CARDBOARD BOX**

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[21] Appl. No.: **457,559**

[30] **Foreign Application Priority Data**

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May 5, 1973 Japan 48-49912

[52] **U.S. Cl.** ..... **93/94 PS;** 93/44; 93/58 R; 93/59 CE; 93/81 MT

[51] **Int. Cl.**[2] **B31C 11/02**

[58] **Field of Search** ..... 93/94 PS, 94 R, 80, 77 R, 93/77 CL, 81 R, 81 MT, 44, 44.1 R, 39.2, 39.3, 58 R, 59 R, 59 CE, 36 M, 36 R

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Primary Examiner—Roy Lake
Assistant Examiner—James F. Coan
Attorney, Agent, or Firm—Wenderoth, Lind & Ponack

[57] **ABSTRACT**

A process and apparatus for the continuous manufacture of a corrugated cardboard box made from a corrugated tube produced by means of forming successive corrugations on a liner strip. A stitchless and strengthened corrugated cardboard box is provided by attaching to the liner strip at least one corrugated strip intermittently on a liner strip.

33 Claims, 37 Drawing Figures

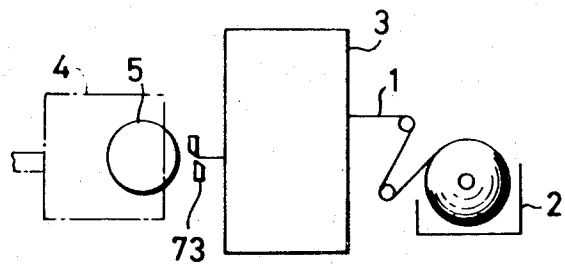


Fig. 1A

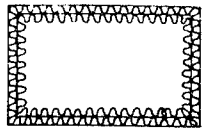


Fig. 1

Fig. 4

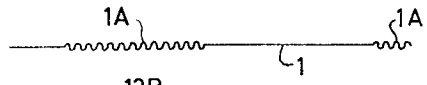
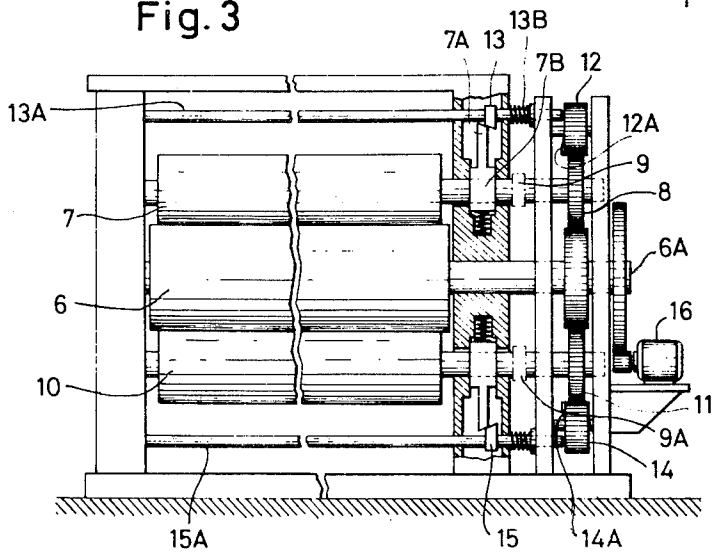


Fig. 3



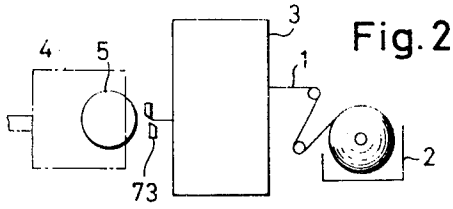
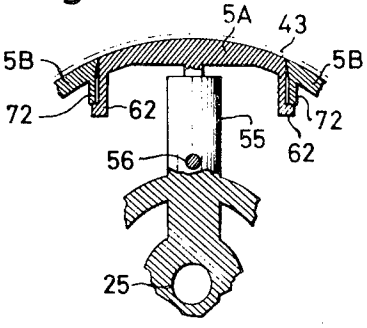


Fig. 2

Fig. 14



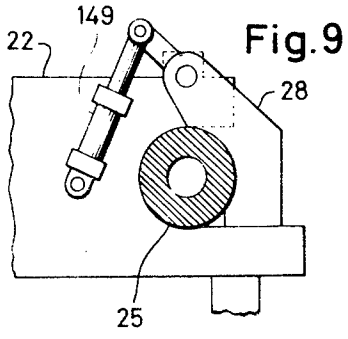


Fig. 9

Fig. 5

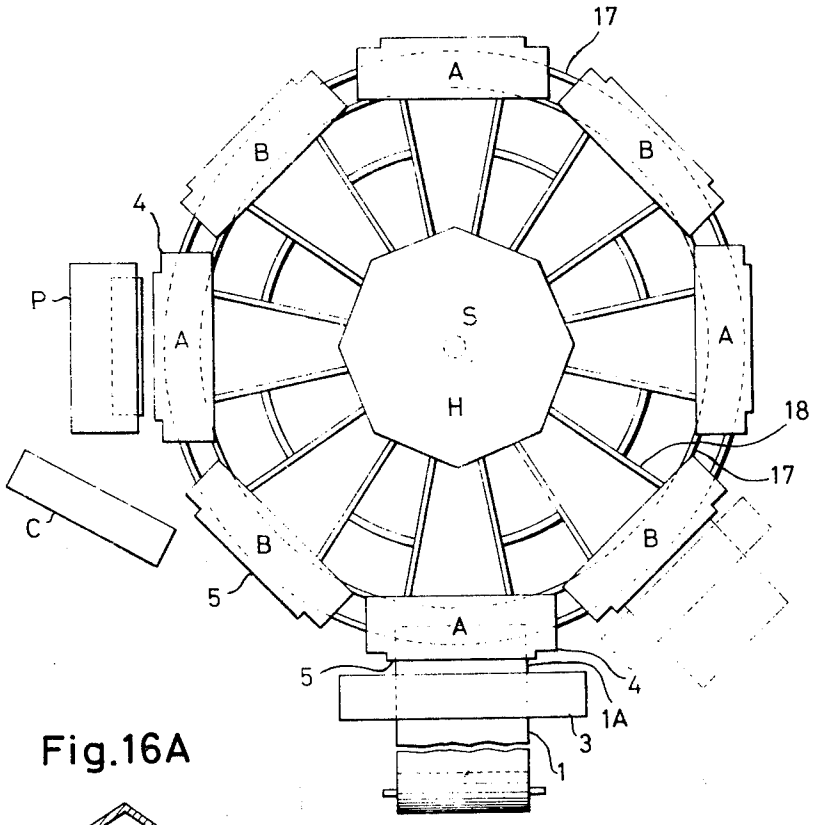


Fig.16A

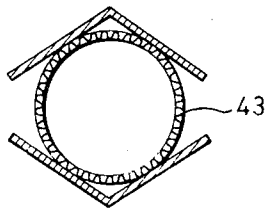


Fig.16

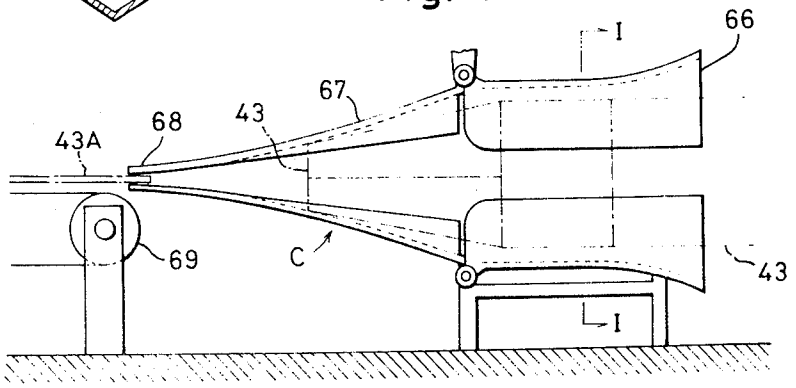


Fig. 6

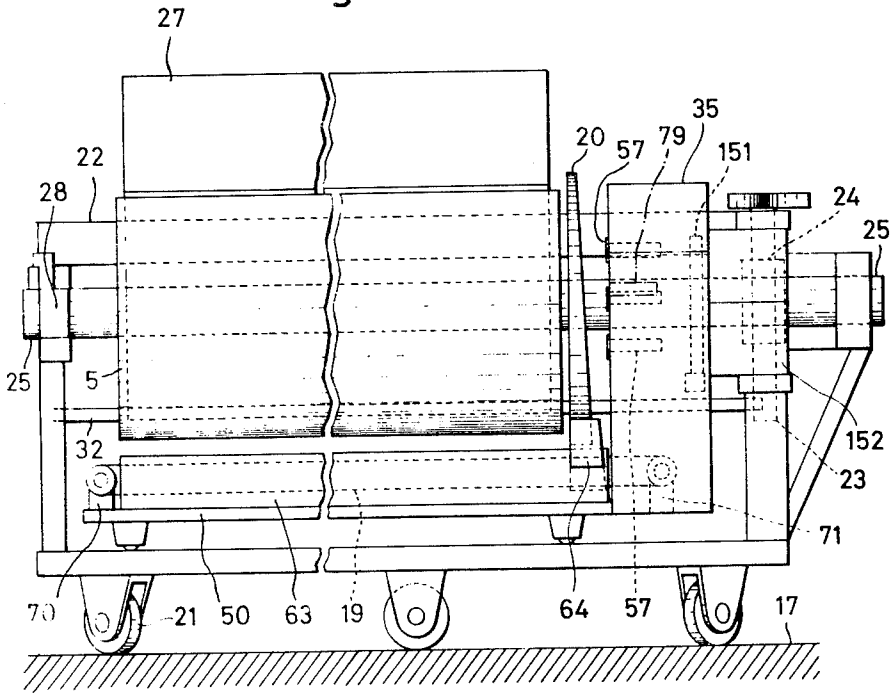

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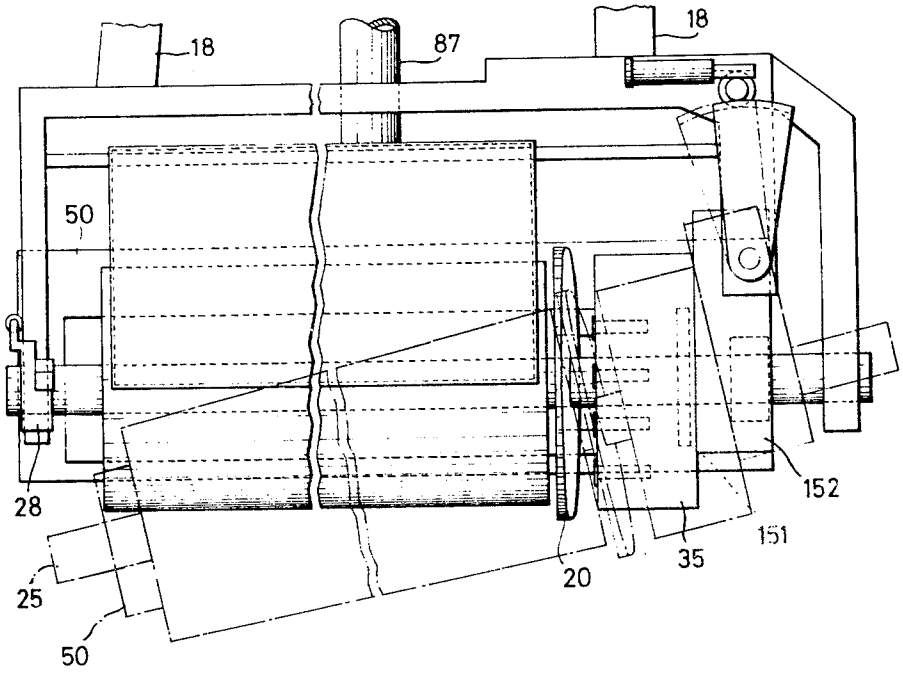
Fig. 7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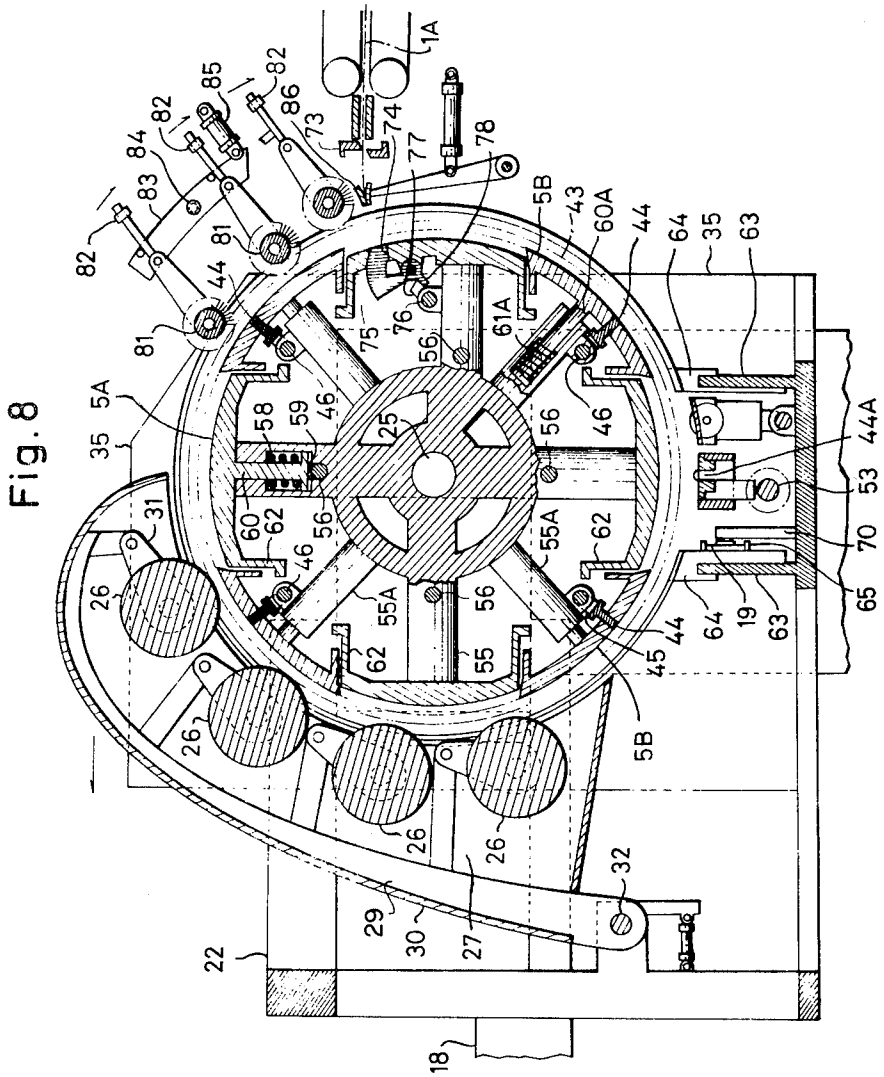


Fig. 8

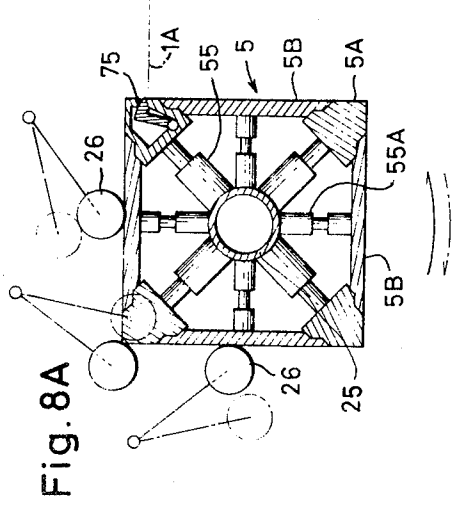


Fig. 8A

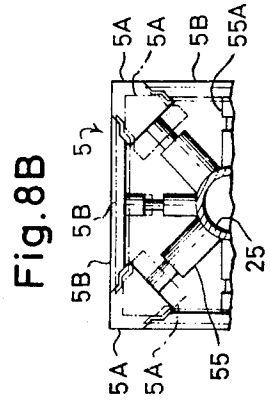


Fig. 8B

Fig. 10

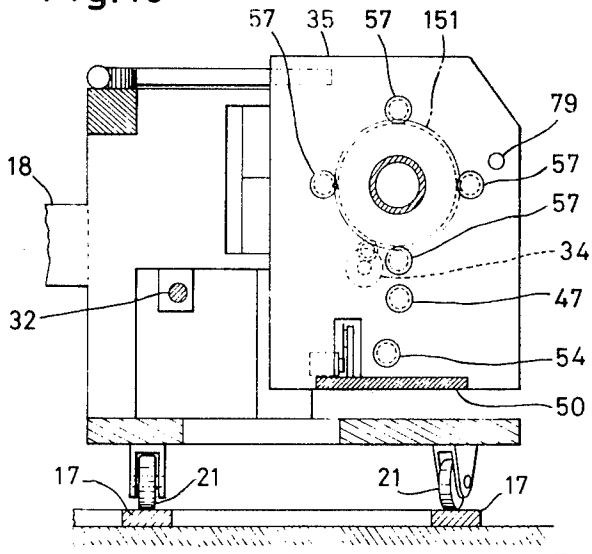


Fig. 6A

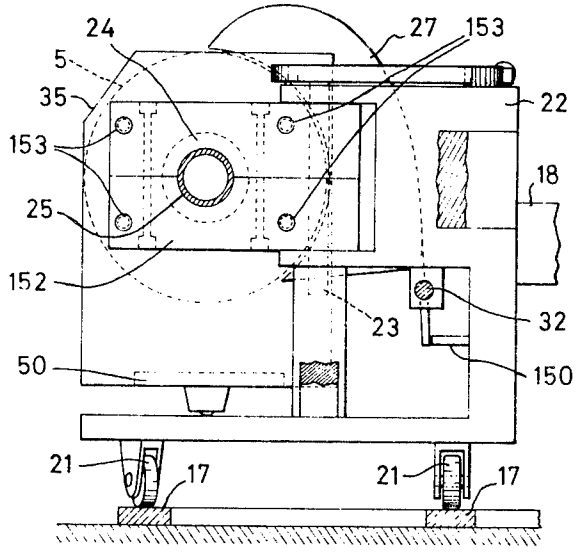


Fig. 20

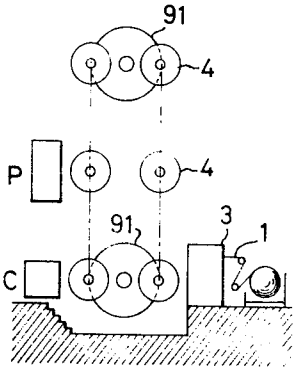


Fig. 32

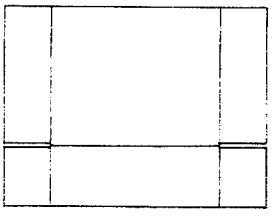


Fig. 21

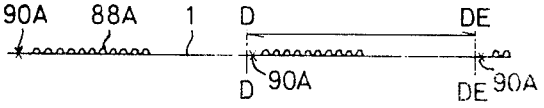


Fig. 22

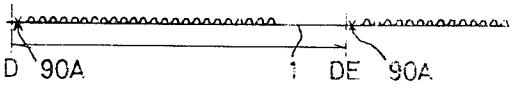


Fig.11

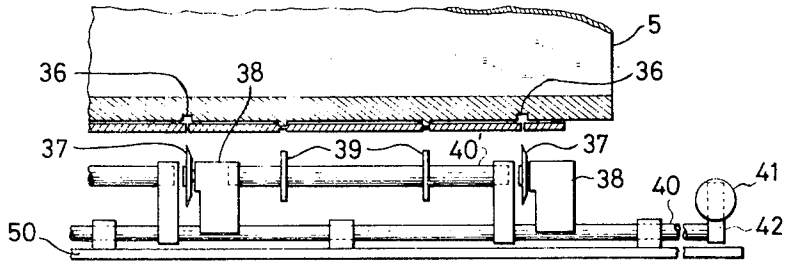


Fig.12

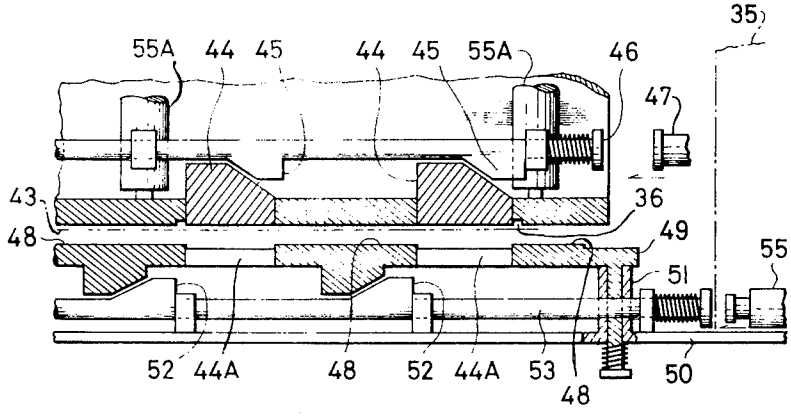
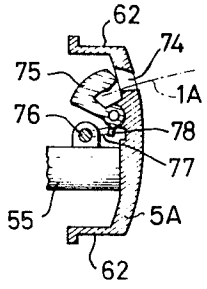


Fig.18



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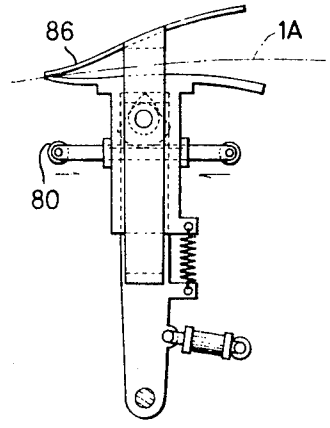

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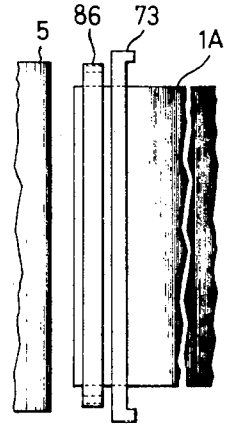

Fig. 13

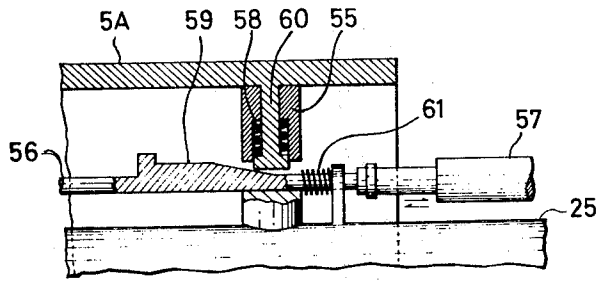

Fig. 15

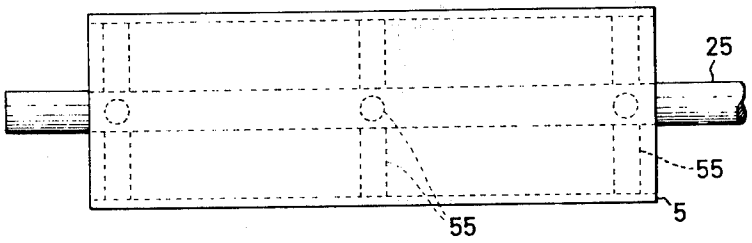

Fig. 28

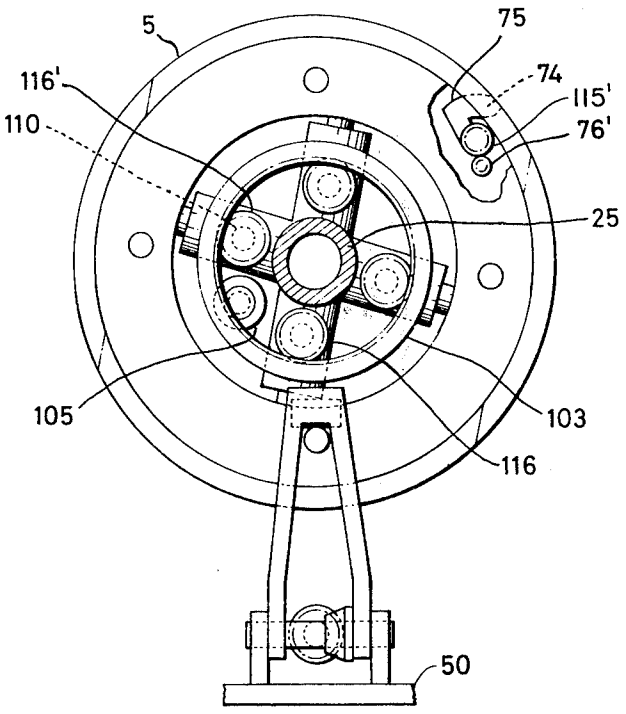

Fig. 25

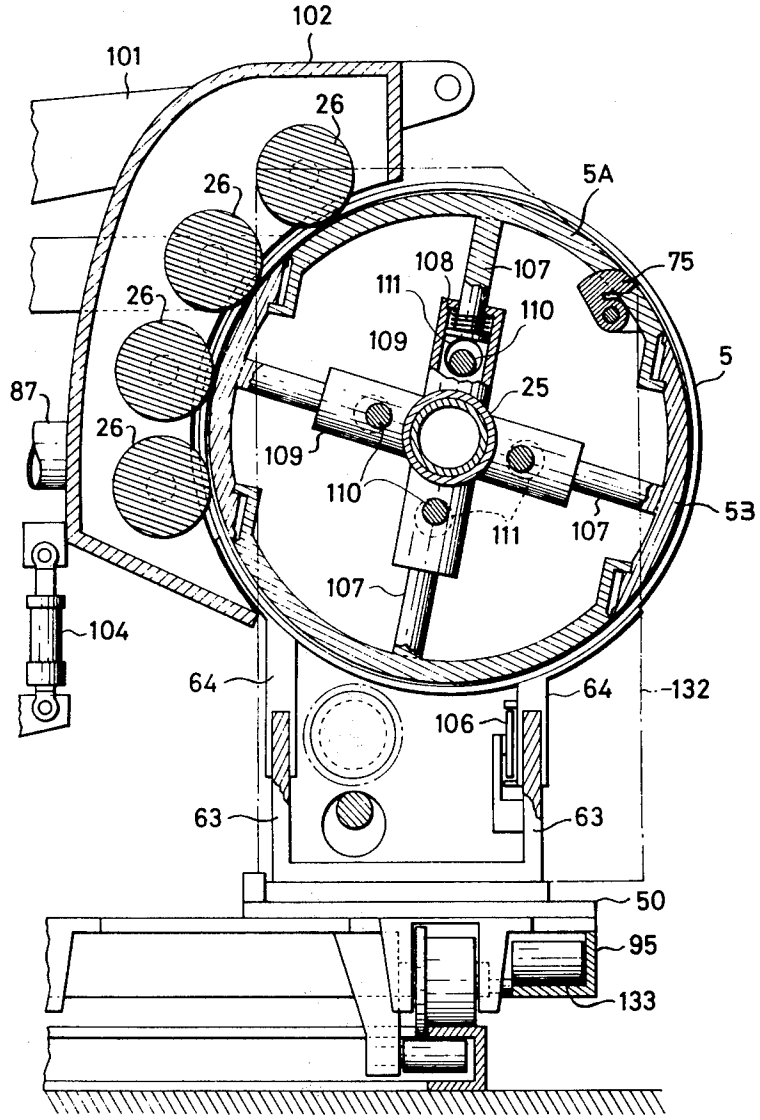
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Fig. 27

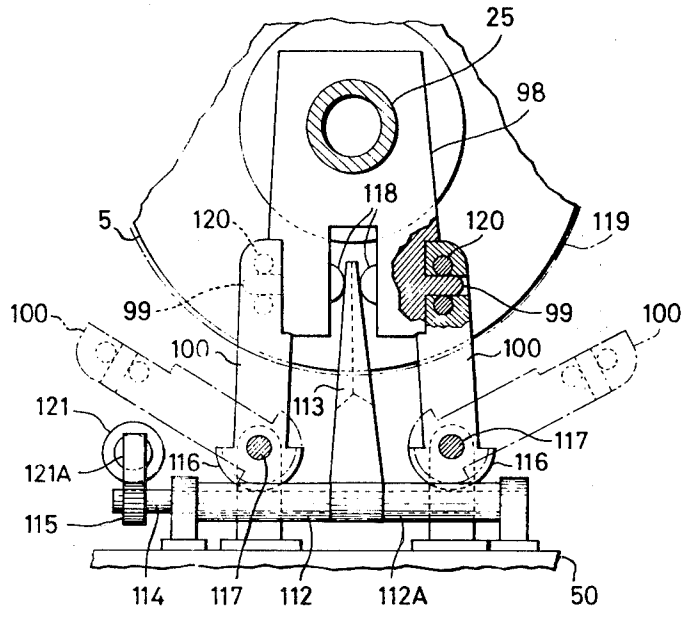
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Fig. 26

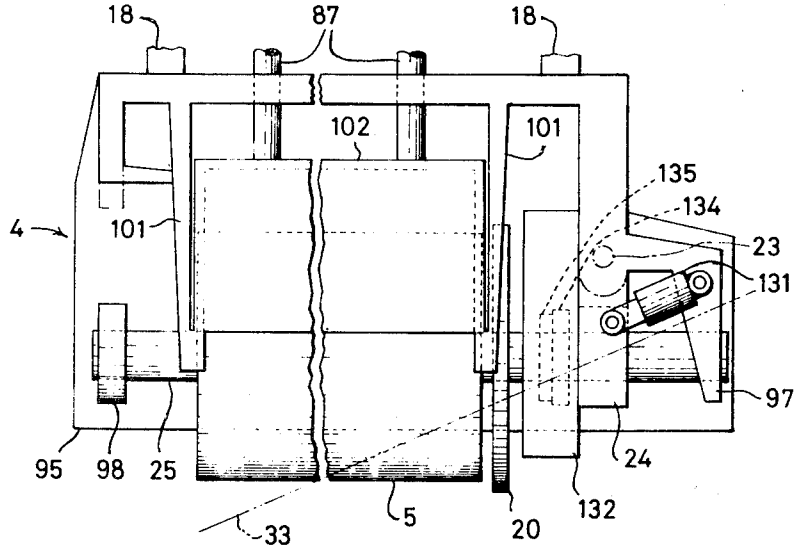
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Fig. 29

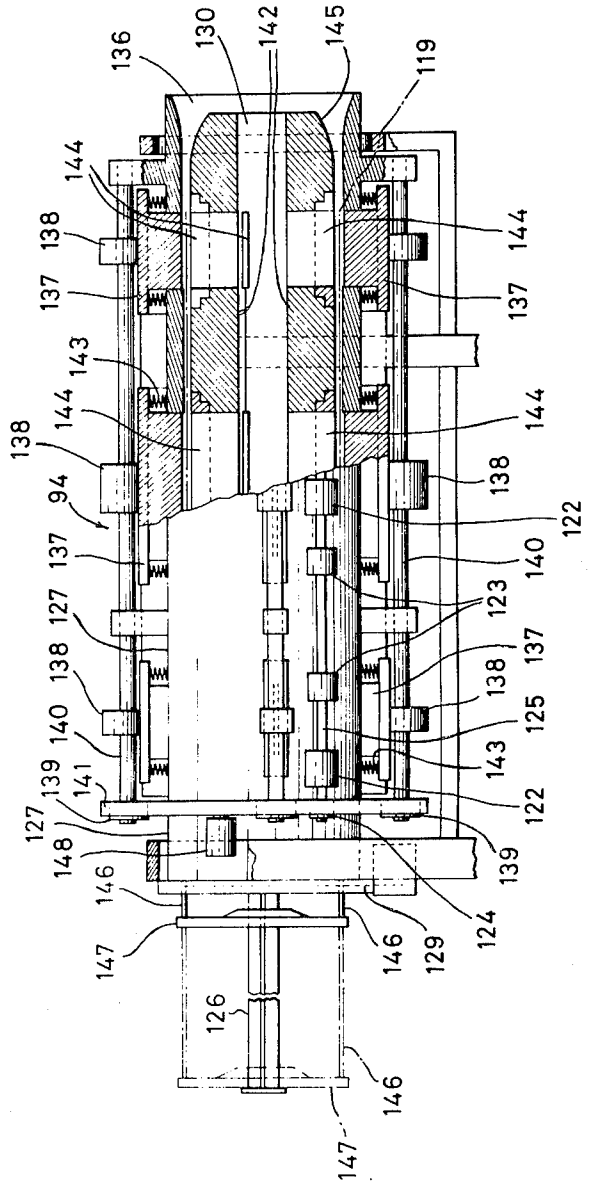
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Fig. 23

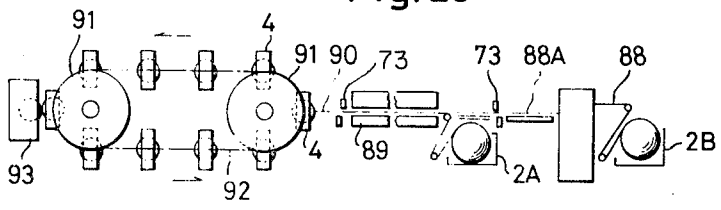


Fig. 24

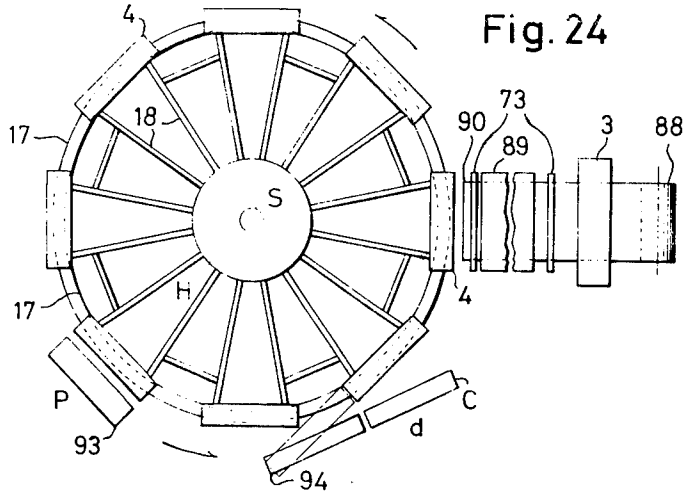


Fig. 30

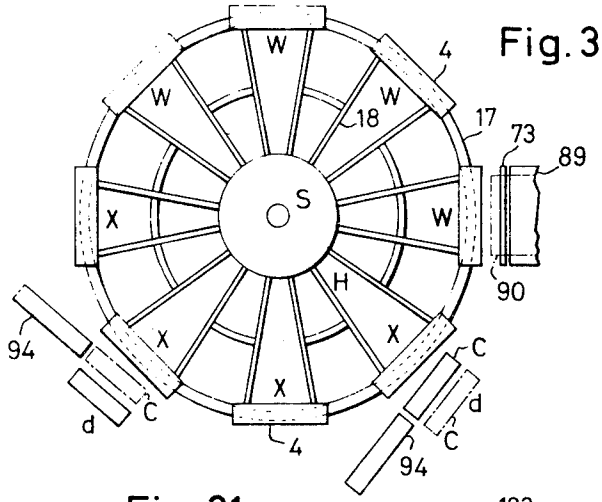
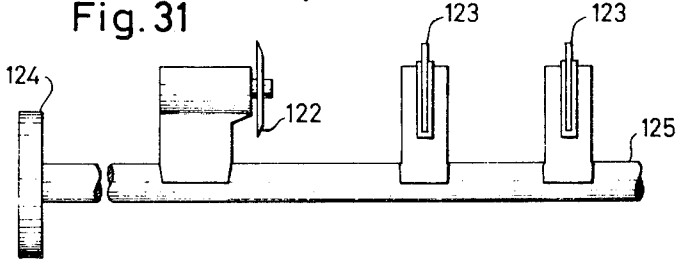


Fig. 31



PROCESS AND EQUIPMENT FOR CONTINUOUS MANUFACTURE OF CORRUGATED CARDBOARD BOX

BACKGROUND OF THE INVENTION

The present invention relates to the production of a carrugated cardboard box made from a corrugated tube produced by means of forming successive corrugations on a liner strip, intermittently at regular intervals thereon, and using such strip as the material strip.

In the prior art production of a corrugated cardboard box, it has been general practice to produce a material strip by sticking two plain liner strips on both sides of a corrugated strip and executing such processing operations as severing, slotting, line ruling and stitching on such material strip. It has also been known to manufacture a corrugated cardboard box of a specific size by a consistent method of manufacture i.e. from the supply of a liner strip to the stitching process.

However, these known methods require both large equipment and a large labor force. Particularly, it is very difficult when using these known methods to manufacture corrugated cardboard boxes of different circumferential lengths and height by the same equipment at the same time. Therefore, they can never be completely satisfactory to manufacturers. When considering that the cost of materials occupies 70–75% in the cost of a product, there exists a pressing need for manufacturers operations wherein 10–20% of the material is lost in the course of manufacture.

SUMMARY OF THE INVENTION

The present invention solves the problem of large capital investment, and offers a method of continuous manufacture of corrugated cardboard boxes of different circumferential length and height.

An object of the present invention is to form successive corrugations on a plain liner strip intermittently at regular intervals by drawing out the liner strip from one mill roll stand and passing the liner strip through a new corrugating machine.

Another object of the present is to provide a corrugated cardboard box made of a stitchless tubular blank formed by overlappingly winding the liner strip with corrugations thereon around a mandrel provided in a shaping device and joining the overlapped parts together.

Another object of the present invention is to provide a corrugated cardboard box made from a stitchless tubular blank formed by means of a continuously drawing out a liner strip, sticking or gluing corrugated strips on one side of the liner strip at regular intervals therealong, thus producing a material strip with corrugations intermittently on one side, overlappingly winding the material strip around a mandrel provided in a shaping device, and joining the overlapped parts together.

BRIEF DESCRIPTION OF THE DRAWINGS

The aforementioned objects and advantages of the present invention will be explained further in detail in the following description, with reference to the attached drawings, wherein:

FIG. **1** and FIG. **1A** are schematic views showing corrugated cardboard boxes manufactured in accordance with the present invention;

FIG. **2** is a schematic view showing a system from the supply of the material strip to the mandrel;

FIG. **3** is the partial elevation view of the corrugating machine which intermittently forms corrugations on the liner strip;

FIG. **4** is the partial schematic view of a liner strip manufactured by the device shown in FIG. **3**;

FIG. **5** is a plan view showing a number of shaping devices arranged on an endless track whereupon they circulate in a counterclockwise direction;

FIG. **6** is a front view of the shaping device with a mandrel and a dryer;

FIG. **6A** is a side view of the device shown in FIG. **6**;

FIG. **7** is a plan view of the device of FIG. **6**, the broken line illustrating a mandrel the shape of which has been changed to a taper and which has turned to a prescribed position;

FIG. **8** is a sectional side view showing the shaping device with a holding arm, and wherein to facilitate understanding of the structure of the mandrel, the engagement between adjacent dividing frames is shown on different levels;

FIG. **8A** is a side view showing the mandrel formed as a square;

FIG. **8B** is a partial side view showing the movement of the mandrel with respect to the hollow shaft;

FIG. **9** is a side view showing the opening and closing of a bearing which supports one end of the mandrel hollow shaft;

FIG. **10** is a left side view of the power box with the driving motor and pressure cylinders employed in the present invention;

FIG. **11** is a partially sectioned view showing a device for severing and horizontal line ruling of the tubular blank;

FIG. **12** is a partial sectional view of a slotting and vertical line ruling device;

FIG. **13** is a partially sectioned view showing a device for moving the dividing frames of the mandrel with respect to the pillar-shaped cylinders thereof;

FIG. **14** is a partially sectioned side view showing the joint edges between adjacent of the dividing frames;

FIG. **15** is a plan view showing the arrangement of the pillar-shaped cylinders within the mandrel;

FIG. **16** is a side view of a device for flattening the boxes;

FIG. **16A** is a vertical sectional side view along the line I—I in FIG. **16**;

FIG. **17** is a partial side view of a liner strip inserting device for feeding a strip to the mandrel;

FIG. **18** is a partially sectioned side view of a liner holding hole into the mandrel;

FIG. **19** is partial plan view of a liner cutter;

FIG. **20** is a schematic view showing the continuous manufacturing device of the invention with a vertical structure;

FIG. **21** is a schematic view showing a material strip for producing a corrugated cardboard box with one corrugation layer;

FIG. **22** is a schematic view showing a material strip for producing a corrugated cardboard box with two corrugation layers;

FIG. **23** is a schematic view showing a system for manufacturing the corrugated cardboard box from the liner strip;

FIG. **24** is a plan view showing a system for manufacturing the corrugated cardboard box by supplying the liner strip to shaping devices which circulate on an endless track;

FIG. 25 is a sectional side view of a shaping device mounted on a cart;

FIG. 26 is a plan view of the shaping device;

FIG. 27 is an end view of a free bearing which supports one end of the mandrel;

FIG. 28 is a side view showing driving devices which change the shape of the mandrel to a taper;

FIG. 29 is a partially sectioned side view of slotting and line ruling device;

FIG. 30 is a plan view, similar to FIG. 24, but illustrating how to produce tubular blanks of different circumferential lengths by two shaping devices;

FIG. 31 is a partial elevation view of a horizontal line ruling device to which a horizontal line ruler and a cutter are fixed; and

FIG. 32 is a plan view of a folded corrugated cardboard box manufactured in accordance with the present invention.

DETAILED DESCRIPTION OF THE INVENTION

An embodiment of the overall system of the present invention is schematically shown in FIG. 2, wherein a plain strip 1 having been prepared to have corrugations formed therein is withdrawn from a mill roll stand 2, passed through a corrugating machine 3, wound around a mandrel 5 provided in a shaping device 4, and combined together so as to form a stitchless tubular blank. When the circumference of the mandrel 5 is 150cm, it is possible to produce a tubular blank with a single corrugation layer by means of winding a liner strip of total length of about 480cm consisting of a plain part of about 160 cm, a corrugated part of about 160cm and another plain part of about 160cm, and combining these parts together while on the mandrel.

The corrugating machine 3 shown in FIG. 3 is very similar to the conventional machine in that it is equipped with a humifier and a driving means to drive a roller having a corrugated surface. On the other hand, it has such structure and function as follows. The main shaft 6A of an intermediate roller 6 is supported by a fixed bearing. The shaft of an upper roller 7 is supported by a floating bearing 7B equipped with a shaft rod 7A so that it may receive the pressure of a spring to push bearing 7B upwardly. The end of the shaft of roller 7 is connected with the shaft of a gear 8 via a flexible joint 9. The shaft of a lower roller 10 also is connected with a shaft of a gear 11 via a flexible joint 9A. A cam 12A is fixed to a gear 12 in engagement with a gear 8 and gives periodical pressure to the end of a shaft 13A to which a cam 13 is fixed. Similarly, a cam 14A is fixed to a gear 14 in engagement with the gear 11 and gives periodical pressure to the end of a shaft 15A to which a cam 15 is fixed.

When a driving motor 16 is operated, the intermediate roller 6 rotates, and motion is transmitted to the gear 12 via the gear 8 whereby cam 12A presses the end of the shaft 13A periodically. The cam 13 presses the cam surface of shaft rod 7A, thereby moving bearing 7B and the central axis of the upper roller 7 downwardly toward the central axis of the intermediate roller 6. When the shaft 13A is released from the pressure of the cam 12A, it returns to its original position due to the elastic effect of a spring 13B which has hitherto been compressed. Accordingly, the floating bearing 7B is pushed up by the spring therebeneath as seen in FIG. 3, and the central axis of the upper roller moves away from the central axis of roller 6.

From such a series of movements as above, it will be observed that the central axis of the lower roller 10 moves toward and away from the central axis of the intermediate roller 6 due to the periodical pressing on the end of the shaft 15A by the cam 14A of gear 14 with which the gear 11 engages. The distance of such upward and downward movement of the upper and lower rollers toward and away from the intermediate roller is 2–8mm, depending on the height of flutes to be formed. It is preferable that the timing for the movement of the central axis of the upper roller 7 toward and away from the intermediate roller 6 is set slightly in advance of the timing for the movement of the lower roller 10. This facilitates defining the length of the corrugated part exactly.

The corrugating machine 3 forms a series of successive corrugations 1A on the plain strip 1 intermittently as shown in FIG. 4, while working continuously and carrying out predetermined operations periodically. The material strip is then grasped or held by a material strip feeding device 86 as shown in FIG. 17, and from there is supplied to the mandrel 5.

As described above, the distance of upward and downward movement of the upper and lower rollers is so small that it is not absolutely necessary for flexible joints 9, 9A to be provided. These joints may be omitted when bringing the present invention into operation.

An appropriate number of shaping device 4 each having a mandrel 5 are mounted on an endless track as shown in FIG. 5, and are supported by holding arms 18 at even intervals around a holding shaft S. These shaping devices 4 rotate while repeatedly starting and stopping and executing such operations as sticking or gluing, drying, vertical line ruling, slotting, horizontal line ruling and severing, to thereby form a processed tubular blank, until the time when the flow of the material strip stops at P point, and then execute printing on the material strip at P point. As regards printing, the conventional aniline printing method (i.e. flexographic printing method) may be used. This method is already known to public, so that the illustration thereof has been omitted in the present specification.

When the shaping device 4 stops at point C, the mandrel 5 turns horizontally as shown in Fig. 7 and an endless chain 19 is shown in FIG. 6 starts circular motion, pulls a pushing ring 20 to contact and push out a corrugated tube held on mandrel 5, the processed corrugated tube (i.e. tubular blank) thus is removed from one side of the mandrel 5. When the corrugated tube is supplied to C, i.e. a flattening device as shown in FIG. 16, a flat corrugated cardboard box 43A discharges from an exit 68. As regards the printing on the tubular blank at point P, it should be noted that the printing may be omitted when bringing the present invention into operation. If it is wished to add the printing process, this can be done by adjusting the printing device so that as soon as the shaping device 4 stops at P point, a pre-set transfer printing roller advances and turns round the circumference of the tubular blank and moves back as soon as it finished the printing. Such printing operation is already known to public, so that further detailed explanation thereof is omitted in the present specification.

One of the special features of the present invention is the simultaneous manufacture of corrugated cardboard boxes of different circumferential lengths. This can be easily carried out by mounting mandrels of different circumferential lengths onto the shaping devices in

such order as A, B, . . . as shown in FIG. 5 by providing the corrugating machine 3 in an appropriate position. It is also possible to carry out this manufacturing method effectively even in a factory with a small available space if two shaping devices 4 are placed on two stages, i.e. an A shaping device on a lower stage and a B shaping device on an upper stage. Further, it will be observed that the simultaneous manufacture of corrugated cardboard boxes being the same in the length of the circumference but different in height can be easily carried out by appropriately changing such operations as vertical line ruling, slotting, horizontal line ruling and severing which are shown in FIGS. **11** and **12.**

The present invention is particularly directed to reducing the loss of materials as much as possible. For example, in order to manufacture a corrugated cardboard box which has a square bottom and which is 30cm in height and 160cm in circumference, it is necessary to produce a tubular blank of 70cm in overall length. Taking account of the most economical width for the material strip and employing a material strip about 285cm wide and imparting thereto the abovementioned processing operations, it is possible to obtain four corrugated cardboard boxes from one mandrel at one time. Thus, the very high economical advantages of the present invention involve both the simultaneous and mass production of boxes of different sizes and the reduction of loss in materials.

The shaping device of the present invention has such features as shown in FIGS. **6, 7** and **8,** including a supporting shaft **23** fixed vertically onto one side of a stand **22** having casters **21.** A bearing **24** is provided in a bearing box **152** which is pivotally supported by supporting shaft **23.** A hollow shaft **25** is supported by bearing **24** and the various elements which form the mandrel **5** are mounted along the circumference of hollow shaft **25.** Accordingly, the axis of the hollow shaft **25** and that of the mandrel **5** are identical. Various elements for executing such processing operations as vertical line ruling, horizontal line ruling, slotting and severing are mounted on a bed **50** substantially parallel with the axis of the mandrel **5.** Several pressure rollers **26,** which conduct the sticking of the material strip wound onto the mandrel **5,** are pivotally supported inside of a dryer **27** and are also arranged so that they may come into contact with a part of the circumference of the mandrel **5.** One end of the hollow shaft **25** is supported by a bearing **28** which is opened and closed in accordance with the action of a pressure cylinder **149** as shown in FIG. **9.**

At a stage of withdrawing a tubular blank from the mandrel **5,** which will be explained later, the pressure cylinder **149** is actuated and the bearing **28** opens. The dryer **27** comprises a drying chamber formed by spreading a cover **30** on the outside of an arc-shaped frame **29** which is held at opposite ends thereof by a supporting shaft **32.** Inside the drying chamber, there are two of five pressure rollers **26** arranged so that their opposite ends are supported by freely swinging arms **31.** The pressure cylinder **150** (see FIG. **6A**) provided in a position near the supporting shaft **32** works at a predetermined timing and moves the dryer **27** away from the side of the mandrel **5.** The dryer **27** approaches the mandrel **5** as shown in FIG. **8** immediately after a new material strip is wound around the mandrel **5.** The pressure rollers **26** contact the circumference of the wound strip while giving almost even pressure thereto and, coupled with the action of hot air fed from the outside, provides for good sticking or gluing of the superimposed or overlapping layers of the material strip.

The rotation of the mandrel **5** is carried out, as shown in FIG. **6** and **10,** by attaching a linking gear **151** to an appropriate portion of the hollow shaft **25** and driving the linking gear **151** by the driving gear of a driving motor **34** via a small gear. A power box **35** to accomodate the driving motor **34** contains not only pressure cylinders **47** and **54** for executing such operations as vertical line ruling, horizontal line ruling, slotting and severing, but also pressure cylinders **57** for converting the shape of the mandrel **5** into a tapered shape, as will be explained later, and another pressure cylinder **79** for blocking a holding hole to restrict the edge of the material strip to be fed. The power box **35** is fixed on one end of the bed **50** and is attached to the bearing box **152** by fixing bolts **153** as shown in FIG. **6A.**

In order to carry out necessary severing operation, annular cut slots or grooves **36** are provided at appropriate portions along the circumference of the mandrel **5** as shown in FIG. **11.** In positions opposite to cut slots **36** are provided disc-shaped cutters **37** respectively connected to cutter motors **38,** while horizontal line ruling wheels **39** are mounted appropriately onto a supporting shaft **40'.** Motors **38** and the supporting shaft are fixed onto a horizontal line ruling rod **40,** and they rise and fall in accordance with the movement of a horizontal line ruling lever **42** connected to and operated by a horizontal line ruling cylinder **41.** During the abovementioned operation, the mandrel **5** keeps rotating.

As shown in FIG. **12,** in the internal portion of the mandrel **5** which is divided into several parts in its axial direction, severing cams **45,** which respectively push slotter devices **44** toward the circumferential portion of the mandrel **5,** are fixed on a slotting rod **46** which has a restoring spring on its end and which moves to a position opposite slotting pressure cylinder **47** periodically and regularly. On the other hand, vertical line ruling blades **48,** which have a section of almost half of a circle in order to press a vertical line in the material, and female blades **44A** of the slotter device **44** are appropriately fixed to a tubular blank supporting stand **49.** The leg of supporting stand **49,** which moves up and down, is inserted into a supporting cylinder **51** fixed appropriately on the bed **50.** A spring is inserted around the leg of stand **49** to abut the bottom of the supporting cylinder **51** and is retained thereon by a nut. When a piston of the vertical line ruling cylinder **55** pushes one end of the vertical line ruling rod **52** equipped with vertical line ruling cams **52,** these cams push the tubular blank supporting stand **49** upwardly toward the mandrel **5,** thereby presssing the circumference of the tubular blank wound on the mandrel **5.** Slotter devices **44** are moved downwardly by the action of cylinder **47,** rod **46** and cams **45,** and are brought into engagement with the female blades **44A.** At the same time the vertical line ruling blades **48** carry out the prescribed line ruling.

As shown in detail in FIGS. **7** and **13** (cf. FIG. **8**), the mandrel **5** may be appropriately divided into four to eight parts by dividing frames which consist of long and slender parts **5A** and **5B** which extend parallel to the axis of the mandrel **5.** Further, the edges of the dividing frames meet and separate as shown in FIG. **8,** so that the shape of the mandrel **5** may be timely converted into a tapered shape to facilitate the withdrawal of the

shaped tubular blank. Thus, it will be observed that the method of the present invention makes it possible to reduce the length of circumference of the mandrel **5** as desired.

That is to say, each dividing frame **5A** is positioned with a piston-shaped leg **60** thereof extending into a pillar-shaped cylinder **55**, one end of which is fixed on the circumference of the hollow shaft **25**. Frame **5A** is urged toward the hollow shaft **25** by a spring **58**. Rod **56**, to which a tapered cam **59** is fixed, appropriately passes through holes made in each pillar-shaped cylinder **55** and one end thereof is arranged to receive pressure of the piston of one of the taper pressure cylinders **57** mounted on the power box **35**. At the end of the rod **56** there is provided a strong restoring spring **61**, which pulls back the rod **56** as soon as the piston of the taper pressure cylinder **57** returns to its original position, and thus the mandrel which had been converted into a tapered shape by tapered cams **59** is restored to its normal shape.

On the other hand, each dividing frame **5B** is also positioned with a piston-shaped leg **60A** thereof extending into a pillar-shaped cylinder **55A**, one end of which is fixed on the hollow shaft **25**. Frame **5B** is urged toward the hollow shaft **25** by a pressure spring **61A**. Edges **72** of each frame **5B** are always supported by edge hooks **62** of the adjacent frames **5A**. Thus, when the taper pressure cylinders **57** act, the dividing frames **5B** are moved with respect to the hollow shaft **25**, by springs **61A**, along with the dividing frames **5A**, and consequently the mandrel **5** is converted into a tapered shape having a partially reduced circumference.

As shown in FIGS. **6** and **8**, the pushing ring **20** for pushing out or removing the tubular blank is formed with a slightly larger diameter than the mandrel **5**, and is equipped with a sliding leg **64** and is mounted in a sliding stand **63** fixed on the bed **50**. Onto a sprocket wheel connected to a sprocket wheel plate **70** by a shaft, is mounted endless chain **19** which has hooks to engage with a stopper **65** fixed appropriately onto the sliding leg **64**. Accordingly, as soon as the mandrel **5** starts rotation and is converted into a tapered shape, a chain motor **71** starts rotation and the pushing ring **20** slides while pushing one side of the tubular blank **43**. The tubular blank is fed into a flattening device as shown in FIG. **16**. Blank **43** enters from an inlet **66**, passes a taper guide **67**, comes out from an outlet **68** in a flattened form **43A**, is placed on a collecting conveyer **69** and is appropriately disposed of.

As shown on the right of FIG. **8**, the liner strip **1A**, on which successive corrugations have been formed intermittently by the aforestated corrugating machine **3**, passes through a liner cutter **73** shown in FIG. **19** which works regularly and periodically, is inserted into a liner holding hole **74** in one frame **5A** as shown in FIG. **18** by an inserting device **86** of such shape as shown in FIG. **17**, and is temporarily stopped by a liner strip holder **75**. The liner strip holder **75** is generally made slightly longer than the width of the liner strip and has a raising claw **78** provided thereon to receive pressure from a pressing claw **77** fixed on a screw rod **76** which is supported by an appropriate bearing. When the head portion of the liner strip **1A** is inserted by about **5cm** into the opened liner strip holding hole **74** while projecting from the inserting device **86**, the piston of screw pressure cylinder **79** (see FIG. **10**), which had been pressing one side of the screw rod **76**, retracts, and a twisting spring mounted on the screw rod **76** twists the twisted screw rod **76**, thereby causing the pressure claw **77** to release the raising claw **78** and the liner holder **75**. A pressure spring thus moves holder **75** to press and hold the entire width of the head part of the liner strip.

As one end of a charge lever **80** of the inserting device contacts the mandrel **5**, the holding or claw portion of the inserting device **86** opens, thus releasing the head part of the liner strip. The inserting device then returns to its original position, spaced from mandrel **5**, in preparation for the next action. When the mandrel **5** rotates, the liner strip holding hole **74** opens only in accordance with the action of the screw pressure cylinder **79**. Accordingly, it will be observed that the wound liner strip forms a tubular blank and remains in that shape on the mandrel until the pushing ring **20** starts movement by the aforestated arrangement.

As shown in FIG. **8**, roller brushes **81** are respectively supported by supporting arms which are respectively mounted on spindles provided on a mounting plate **83** and which at their rear ends are each equipped with an adjustable weight **82** in order to increase or decrease rotary pressure of the roller brush to be given to the surface of the liner strip. Each roller brush is arranged in such a way that it turns while being pressed toward the circumference of the mandrel **5** so that the liner strip can be smoothly overlappingly wound thereon. When the winding process finishes, a pressure cylinder **85** connected to the mounting plate **83**, which is pivotally supported by shaft **84**, is actuated before the shaping device **4** starts motion. Thus, the mounting plate **83** swings, and each roller brush releases its pressure on the tubular blank **43**. Whether a group of such roller brushes is employed for each shaping device or whether they should be mounted on only the upper portion of the liner strip inserting device is optional.

Another object of the present invention is, as shown in FIG. **21**, to produce a material strip for a corrugated cardboard box with one corrugation layer by means of sticking or gluing a corrugated strip **88A** on one side of a plain liner strip **1** at regular intervals. In this case, it is preferable to make the length of the portion of the strip where the corrugated strip is stuck less than that of the portion consisting of the plain liner strip alone.

Further, the present invention contemplates the provision of a material strip for a corrugated cardboard box with two corrugation layers as shown in FIG. **22**. This is carried out by a means similar to those mentioned above. In this case, the length of the portion of the strip where the corrugated strip **88A** is stuck is about two times longer than the portion consisting of the plain liner strip alone.

As shown in FIG. **23**, a mill roll stand **2A** draws out a plain liner strip **1**, while a mill roll stand **2B** draws out another liner strip **88**, which is changed to a corrugated strip **88A** by a corrugating machine **3** and passes through a corrugated strip cutter **73** and is applied with an adhesive agent on its one side and then is stuck on the liner strip **1**. The corrugated strip **88A** is cut in regular lengths and transported and stuck to the liner strip **1** at regular intervals. The thus prepared strip passes through a material strip drying section **89** equipped with a group of pressure rollers and becomes a material strip **90**. Strip **90** passes through a material strip cutter **73** and is fed by an appropriate feeding device to the tubular mandrel **5** mounted on a shaping device **4**. Thus, the regularly severed material strips are overlappingly wound around the mandrel.

It will be observed that in order to obtain a corrugated cardboard box with one corrugation layer, the corrugated strip with a length D–DE as shown in FIG. **21** may be wound on the mandrel, while to obtain a box with two corrugation layers, the corrugated strip with a length D–DE as shown in FIG. **22** may be overlappingly wound on the mandrel.

In FIG. **23**, a number of shaping devices **4** are mounted on an endless chain **92** extending around large sprocket wheels **91**. The material strip **90** is fed to these shaping devices while they are circulating, and is changed to a cylindrical corrugated tube (hereinafter it is described as a tubular blank). It is further given such processing operations as line ruling, slotting and severing which are to be explained later and also printed by a printing device **93** if required. Then, it is drawn out from the mandrel and is finished as a flat folded corrugated cardboard box.

Another object of the present invention is to obtain a corrugated cardboard box by, as shown in FIG. **24**, arranging a number of shaping devices **4** to be supported by holding arms **18** and to circulate on an endless track with the circulation shaft as its center. The material strip **90** is fed to mandrels provided in these shaping devices **4**, and the mandrels respectively overlappingly wind up the material strip and form a tubular blank. The blank is transferred to a slotting and line ruling device **94**, then passed through a flattening device C, and then removed as a folded corrugated cardboard box.

As shown in FIGS. **25** and **26**, the shaping device **4** comprises a device stand fixed on a cart **95** equipped with a sliding wheel, and the shaping device **4** is held by holding arms **18** which project radially from the center shaft S. On one side of the device stand are provided a bearing **24** to support a neighboring part of one end of the hollow shaft **25** to which the mandrel **5** is mounted and a shaft guide **97** to reduce flection resistance to be given to bearing **24**. The other end of the hollow shaft **25** is equipped with a free bearing **98** of such shape as shown in FIG. **27**. To the legs of free bearing **98** are fixed pins **99** which are appropriately restricted by a restricting and holding mechanism including free supporting legs **100** which rise and fall. That is to say, the shaping device **4** stops at point *d* as shown in FIG. **24** and a tubular blank is drawn, but with free supporting legs **100** swinging to the position shown with broken lines in FIG. **27**.

A dryer **102** made of heat resisting material is supported by dryer arms **101** and, when it is moved by the action of dryer pressure cylinders **104** which are connected to both sides of the lower part thereof, it pulls pressure rollers **26** mounted thereon away from the mandrel in order not to disturb the winding of the material strip **90** onto the mandrel and the drawing out of the tubular blank from the mandrel. The hot air to be fed to the dryer **102** via a tube **87** comes from a hot air generator provided in an auxiliary machine room H as shown in FIG. **24**.

The sliding leg **64**, which is equipped with the pushing ring **20** for withdrawing the tubular blank, is appropriately mounted on a sliding stand **63** fixed to a bed **50** and is driven by a chain driving mechanism **106**. This mechanism may be similar to that described above, so that a detailed explanation has been omitted in the present specification.

As shown in FIGS. **25** and **28**, the mandrel **5** comprises long and slender dividing frames **5A** and **5B** over its overall length, to the inside of which are fixed at appropriate intervals pillar-shaped pistons **107**. These pistons are each equipped with a spring **108** and are inserted in pillar-shaped cylinders **109**, one end of which is fixed to hollow shaft **25**. The inner end of each piston **107** is arranged to receive pressure of a taper cam **111** fixed to a taper shaft **110**.

As shown in FIGS. **25** and **28**, one of the dividing frames **5A** or **5B** has a strip holding hole **74** to firmly hold the head part **90A** of the material strip **90** to be inserted therein. A holding lever **75** which is equipped with a gear **115'** on its end is arranged to swing appropriately by a driving mechanism including a driving gear **76'**. When a clutch provided in such mechanism is released, a pressure spring pushes back the holding lever **75** and thus the head part **90A** of the materials trip **90** is held until the tubular blank is withdrawn. The mechanism of this operation will be readily understood, so that detailed explanation has been omitted in the present specification.

As shown in FIG. **28**, a gear **116'** is fixed to the end of each taper shaft **110** so that it may engage with an internal gear **103** driven by a taper motor **105**. When the taper shafts **110** are driven, the taper cams **111** as shown in FIG. **25** push out the pillar-shaped pistons **107**, whereby the edges of outer surface of the dividing frames **5A** and **5B** contact each other, thus forming the cylindrical mandrel. When the taper shafts **110** are returned to their original positions, the pulling springs **108** pull the dividing frames **5A** and **5B** toward the hollow shaft. Accordingly, the mandrel is changed to a slightly tapered shape, thus facilitating the withdrawal of the tubular blank. It is possible to change the driving mechanism from a gear system to a system comprising sprocket wheels and a chain.

According to the present invention, one of the steps to facilitate the manufacture of corrugated cardboard boxes of different circumferential length is to make it easy to exchange the mandrel **5**. It will be observed that it is not only easy to exchange the mandrel but also convenient for maintenance if the mandrel is formed by attaching the pillar-shaped cylinder **109** to the hollow shaft **25**, one end of which is inserted into bearing **98**, and the other end of which is supported by a fixed bearing. The tunnel of the hollow shaft **25** is used to accomodate a tube for fluid pressure and air pressure and wires for electric apparatus, whereby it is possible to receive power from the source provided in a power box **132** through a rotary joint, a rotary pole, etc.

A further object of the present invention is to make it possible to withdraw the tubular blank by such means as mounting a free bearing **98** on one side of the hollow shaft **25**. Application of pressure by a support leg pressure cylinder **121** when the shaping device stops at point *d* as shown in FIG. **24**, actuates a rack **121A** connected directly to a piston of cylinder **121** and drives a gear **115** of a worm shaft **114** equipped with a left worm **112**, a right worm **112A** and a restriction guide **113**. One end of each free supporting leg **100** is fixed to a wheel shaft **117** having a wheel **116**. Thus, the legs are moved to the positions shown with broken lines, and at the same time the restriction guide **113** is separated from between guide pins **118**. When the tubular blank is withdrawn, pressure for return action is fed into the support leg pressure cylinder **121**, and the order of the abovementioned operations is reversed. That is to say, the restriction guide **113** moves between the guide pins **118** and adjusts the position of bearing **98**, the free support legs **100** rise, the restriction pins **99**

move between the opposed restriction rollers **120** provided on each free support leg **100**, and thus the free bearing **98** is held firmly until the next operation for withdrawing another tubular blank begins.

One of the objects of the present invention is to withdraw the tubular blank formed by the mandrel **5** by means of moving the ring **20**, and also to push the blank into the entrance and exit **136** provided on one side of the slotting and line ruling device **94** as shown in FIG. **29.** This operation is carried out by the following arrangement. Slotting cams **138** operating on slotters **137**, and a righthanded ratchet wheel **139** are fixed to each of a plurality of cam shafts **140.** Severing devices **122**, each including a rotary disc-shaped blade, horizontal line rulers **123** and a lefthanded ratchet wheel **124** are fixed to a horizontal line ruling shaft **125.** These elements are driven by an endless chain **141** and a driving device **148.** A suitable bearing device is provided on one end of an integument cylinder **127** equipped appropriately on its outer circumference with pressure springs **143**, which act on vertical line ruling blades **142**, and it supports one end of an inner cylinder **145** which is equipped with slotting female blades **144.** On one end of inner cylinder **145** is fixed a slide guide **126** onto which is fastened a rotary holding plate **147** for supporting a push rod **146** equipped on one end thereof with a push plate or ring in order to remove the tubular blank **119** by pushing the same to the right as viewed in FIG. **29.** Inside guide **126** there is provided a chain drive mechanism extending in the longitudinal direction for moving rotary holding plate **147** to the right and left. A tunnel **130**, to discharge therefrom scraps produced in the process of slotting, is arranged to receive a high speed air supply from one end thereof. The operation of the slide guide **126** and the chain drive mechanism will be readily understood from the above, so that further detailed explanation thereof has been omitted in the present specification.

To explain the abovementioned overall operation further in detail, the slotting device **94** as shown in FIG. **24** is arranged so as to run regularly about a pivot at one end thereof to take a position for insertion therein of the tubular blank from the stopped shaping device **4.** When the tubular blank is pushed into a predetermined position within device **94**, a sensing device instructs the driving device **148** to operate, and the endless chain **141** turns the slotting cam shafts **140** equipped with the lefthand ratchet wheels **139**, whereby the slotting and vertical line ruling processes are executed. During such operation, the horizontal line ruling shaft **125** stops its motion, since the righthand ratchet wheel **124** races. When the slotting process finishes, the driving device **148** turns in a reverse direction, and the horizontal line ruling shaft **125** operates. At the same time the driving device **128** turns the inner cylinder **145** once via a conducting belt **129**, and then stops its movement in preparation for the next operation. When the severing process finishes, the chain driving mechanism equipped on the slide guide **126** starts to operate, and each push rod **146** pushes out the tubular blank through the entrance and exit **136** and moves the blank into the inserting hole of a flattening device C, provided in the opposite position. As shown in FIG. **16**, the tubular blank **43** is pushed in through an entrance hole **66**, is converted into a folded corrugated cardboard box **43A** due to the operation of the taper guide **67**, and is discharged through the discharging hole **68** and then transferred for accumulation by a conveyor **69.** FIG. **29** shows an example of producing plural corrugated cardboard boxes from a single tubular blank.

The installation of a printing device as shown at point P in FIG. **24** should be employed. However, it is preferable that the aniline printing method **93** is employed.

The continuous manufacturing by the above device of the present invention is carried into operation by connecting the shaping devices W and X with different circumferential lengths as shown in FIG. **30**, appropriately arranging the slotting and line ruling device **94** as shown in FIG. **29**, supporting the hollow shaft **25** by a bearing **24** which can turn the hollow shaft **25** of the mandrel **5** and the mandrel **5** as shown in FIG. **26**, and arranging the axis **33** of the hollow shaft **25** so that it may turn to the position as shown with a broken line in FIG. **26.** The transfer of the tubular blank can be simplified by such arrangement to turn the hollow shaft and mandrel by an appropriately provided pressure cylinder **131** only when transferring the formed tubular blank to the stationary slotting and line ruling device **94.**

When the mandrel **5** is turned counter-clockwise, the section of the shaped tubular blank is as shown in FIG. **1.** However, when the mandrel is turned clockwise, corrugations are formed on the inner wall of the tubular blank as shown in FIG. **1A.** The direction of turning the mandrel of course depends on the desired configuration of the finished blank.

In principle, the section of the mandrel **5** should be square as shown in FIG. **8A.** However, it is possible to change it to the cylinderical shape shown in FIG. **8.** In each embodiment in the present invention, the mandrel cross-section is shown as a circle to facilitate the understanding of how to overlappingly wind the material strips

In connection with each embodiment of the invention, it should be noted that the pressure cylinder, electric motor or hydraulic motor, etc. employed as the driving device must be chosen depending on necessity for simplifying the structure of the device, and must not be limited to any specific driving apparatus. For movement on the endless track, it is convenient if a traction engine is formed by providing a hydraulic motor **133** on a cart **95** for driving a running wheel as shown in FIG. **25.** A rotary gear **134** fixed to the hollow shaft **25** and an electromagnetic braking device **135** are linked with the driving device (its illustration has been omitted in the present specification) provided in the power box **132.**

As described hereinbefore, when the shaping device of the present invention circulates on a round track as shown in FIG. **5**, it is economical if these shaping devices are arranged on two to three stages. Further, if the shaping devices are vertically arranged as shown in FIG. **20**, it is possible to install the devices in a small site. It is also possible to arrange the devices horizontally by employing a chain drive system which circulates over two large sprockets. It should be noted that all these arrangements are encompassed by the scope of the present invention.

As described hereinbefore, the continuous manufacturing device of the present invention is provided with a control system to control the timing of operation of each element of each shaping device which circulates on the endless track, to the corrugating machine provided at a fixed position along the endless track, to the printing device and to the material strip inserting device. If pressure cylinders as shown in the drawings are

utilized, it is easy to establish such control system by connecting the above mentioned devices to a prescribed pressure circuit via electromagnetic valves and appropriately arranging the elements which handle the opening and closing of the electromagnetic circuit at appropriate positions in the power box **132.** in the auxiliary machine room and further on the endless track. It is also possible to adapt a purely hydraulic element consisting of the turbulent flow element, or the turbulent amplifying element type, or to use electronic elements for minute adjustment, or to use a purely hydraulic element with a rough control system, or to provide a magnetic tape numerical control system. All of these methods of control will be readily understood by engineers, so that illustration and explanation thereof have been omitted in the present specification.

As described hereinbefore, the present invention is directed to the manufacture of a corrugated cardboard box by inserting one or two material strips, which are continuously withdrawn, into a shaping device and performing prescribed processing operations thereon. The invention also relates to specific devices for the continuous manufacture of such corrugated cardboard box. When carring the present invention into operation, it is of course possible to make changes in design or form of the above described specific structural elements without departing from the scope of the present invention.

What is claimed is:

1. A process for continuously manufacturing flattened corrugated cardboard boxes from a single liner strip, said process comprising:

passing a single liner strip of a selected width through a corrugating machine, and intermittently forming corrugations in said liner strip, transverse to the longitudinal direction thereof, at regular intervals therealong, thus forming a material strip having regularly alternating corrugated portions and non-corrugated portions;

winding a selected length of said material strip circumferentially about a mandrel with at least one said corrugated portion overlapping at least one said non-corrugated portion, and joining said thus overlapped portions, thus forming a blank having a length equal to said width;

thereafter performing known line ruling and slotting processing operations on said blank; and

flattening the thus processed tubular blank to form a flattened corrugated cardboard box.

2. A process as claimed in claim **1,** wherein said mandrel is cylindrical and said blank is thus formed tubular.

3. A process as claimed in claim **1,** wherein said step of winding comprises fixing an end of said material strip to said mandrel; rotating said mandrel, thereby wrapping said material strip around said mandrel; and severing said material strip to achieve selected length thereof.

4. A process as claimed in claim **3,** wherein said known line ruling and slotting operations are performed while said blank is on said mandrel.

5. A process as claimed in claim **3,** further comprising transferring said blank from said mandrel to a line ruling and slotting mechanism, said line ruling and slotting operations being performed on said mechanism.

6. A process as claimed in claim **3,** further comprising circumferentially severing said blank while said blank is on said mandrel thus forming shortened separated blanks.

7. A process as claimed in claim **1,** further comprising providing a plurality of said mandrels; circulating said plurality of mandrels with respect to said corrugating machine; and sequentially supplying selected lengths of said material strip from said corrugating machine to each of said mandrels.

8. A process as claimed in claim **1,** further comprising reducing the outer dimension of a portion of the length of said mandrel, thus providing said mandrel with a tapered shape and facilitating the removal of said blank therefrom.

9. A process for continuously manufacturing flattened corrugated cardboard boxes from one non-corrugated liner strip and one corrugated strip, said process comprising:

providing a first non-corrugated liner strip of a selected width;

providing a second strip of said width having formed therein corrugations extending transverse to the longitudinal direction thereof, and severing said second strip into partial strips of selected length;

fixing said partial strips to said first strip to thereby form a material strip having regularly alternating corrugated portions and non-corrugated portions;

winding a selected length of said material strip circumferentially about a mandrel with at lesat one said corrugated portion overlapping at least one said non-corrugated portion, and joining said thus overlapped portions, thus forming a blank having a length equal to said width;

thereafter performing known line ruling and slotting processing operations on said blank; and

flattening the thus processed tubular blank to form a flattened corrugated cardboard box.

10. A process as claimed in claim **9,** wherein said mandrel is cylindrical and said blank is thus formed tubular.

11. A process as claimed in claim **9,** wherein said step of winding comprises fixing an end of said material strip to said mandrel; rotating said mandrel, thereby wrapping said material strip around said mandrel; and severing said material strip to achieve said selected length thereof.

12. A process as claimed in claim **11,** wherein said known line ruling and slotting operations are performed while said blank is on said mandrel.

13. A process as claimed in claim **11,** further comprising transferring said blank from said mandrel to a line ruling and slotting mechanism, said line ruling and slotting operations being performed on said mechanism.

14. A process as claimed in claim **11,** further comprising circumferentially severing said blank while said blank is on said mandrel thus forming shortened separated blanks.

15. A process as claimed in claim **9,** further comprising providing a plurality of said mandrels; circulating said plurality of mandrels and sequentially supplying selected lengths of said material strip to each of said mandrels.

16. A process as claimed in claim **9,** further comprising reducing the outer dimension of a portion of the length of said mandrel, thus providing said mandrel with a tapered shape and facilitating the removal of said blank therefrom.

17. A process as claimed in claim **9,** wherein said step of providing said second strip comprises passing a liner

strip through a corrugating machine and forming said corrugations therein.

18. A process as claimed in claim **9**, wherein said corrugated portions are each formed with a length less than that of each of said non-corrugated portions.

19. A process as claimed in claim **9**, wherein said corrugated portions are each formed with a length approximately twice that of each of said non-corrugated portions.

20. An apparatus for continuously manufacturing flattened corrugated cardboard boxes, said apparatus comprising:

means for forming a material strip of a selected width and having therein regularly alternating corrugated portions, formed of corrugations extending transverse to the longitudinal direction of said material strip, and non-corrugated portions;

at least one mandrel positioned adjacent said material strip forming means;

means connected to said mandrel for winding a selected length of said material strip circumferentially around said mandrel with at least one said corrugated portion overlapping at least one said non-corrugated portion;

means connected to said mandrel for joining said overlapped portions and for thus forming a blank having a length equal to said width;

means operatively associated with said mandrel for performing known line ruling and slotting operations on said blank; and

means, positioned adjacent said line ruling and slotting means to receive therefrom said blank, for flattening said blank.

21. An apparatus as claimed in claim **20**, wherein said material strip forming means comprises a corrugating machine including means for receiving a single liner strip of said width; and means for intermittently corrugating said liner strip at regular intervals therealong.

22. An apparatus as claimed in claim **20**, wherein said material strip forming means comprises means for supplying a first non-corrugated liner strip of said width; means for corrugating a second strip of said width; means for severing said second strip into partial strips of selected length; and means to fix said partial strips to said first liner strip at regular intervals therealong.

23. An apparatus as claimed in claim **20**, wherein said mandrel is cylindrical and said blank thus formed is tubular.

24. An apparatus as claimed in claim **20**, wherein said winding means comprises gripping means on said mandrel for gripping an end of said material strip, means for rotating said mandrel, and for thereby wrapping said material strip around said mandrel; and means for severing said material strip to achieve said selected length thereof.

25. An apparatus as claimed in claim **24**, wherein said line ruling and slotting means are mounted on said mandrel.

26. An apparatus as claimed in claim **24**, wherein said line ruling and slotting means comprises a separate apparatus positioned to axially receive said blank from said mandrel.

27. An apparatus as claimed in claim **24**, further comprising means, mounted on said mandrel, for circumferentially severing said blank upon rotation of said mandrel, thus forming shortened separated blanks.

28. An apparatus as claimed in claim **20**, wherein said at least one mandrel comprises a plurality of mandrels; and further comprising means for circulating said plurality of mandrels with respect to said material strip forming means, such that each of said mandrels is sequentially supplied with a selected length of said material strip.

29. An apparatus as claimed in claim **28**, wherein said circulating means comprises an endless track, said mandrels being spacedly mounted about said endless track; and means for intermittently moving said mandrels around said track.

30. An apparatus as claimed in claim **20**, further comprising a first bearing mount pivotable about a vertical axis; a first end of said mandrel being fixedly mounted in said first bearing mount; a second bearing mount; a second end of said mandrel being releasably mounted in said second bearing mount; and means connected to said mandrel for swinging said mandrel in a horizontal plane about said vertical axis.

31. An apparatus as claimed in claim **20**, wherein said mandrel includes means for reducing the outer dimension of a portion of the length thereof and thereby tapering the outer configuration thereof.

32. An apparatus as claimed in claim **31**, wherein said reducing means comprises a plurality of individual dividing frames mounted to form the outer surface of said mandrel; and means attached to first ends of said dividing frames for selectively moving said first ends from a first outer position to a second inner position at which the outer mandrel surface tapers inwardly from second ends of said dividing frames to said first ends thereof.

33. An apparatus as claimed in claim **32**, further comprising ring-shaped means normally positioned adjacent said second ends for contacting an end of said blank and pushing said blank from said mandrel in a direction toward said first ends.

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