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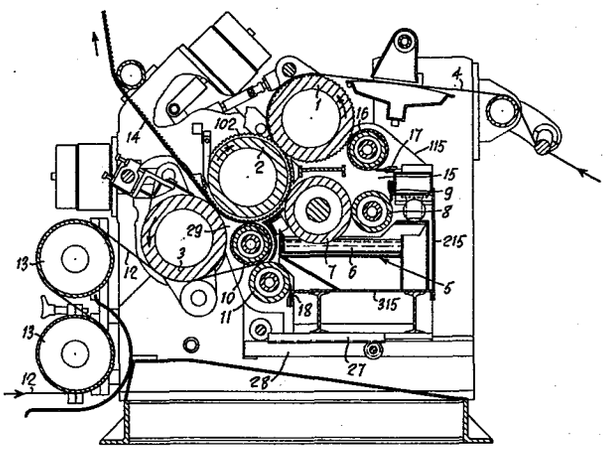
(54) Corrugating unit for manufacturing corrugated board.

(57) This invention relates to a corrugating unit for manufacturing corrugated board. According to the invention, the firm contact of the corrugated paper (4), or corrugated medium, against the shaped surface of the central corrugating cylinder (2) is caused by an air cushion acting on the side of the corrugated paper opposite to that being engaged with the central corrugating cylinder (2), and which is formed and fed in a zone which is divided into controlled decompression sections.



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Corrugating unit for manufacturing corrugated board.

This invention relates to an apparatus for manufacturing corrugated board, and particularly to the corrugating unit, which is an important component of this apparatus.

Notoriously, the corrugating unit of an apparatus for manufacturing corrugated board forms the so-called "single-faced corrugated board", i.e. a corrugated paper having glued thereon a plain board or liner. In order to form the single-faced corrugated board, the corrugating unit comprises two cooperating corrugating cylinders, i.e., a so-called inlet cylinder and a so-called central cylinder, both having a corrugated configuration and receiving therebetween the paper to be corrugated. The corrugated paper passed between the pairs of corrugating cylinders is held in firm contact with the corrugated configuration of the central corrugating cylinder, where the ridges or tips

of the corrugated paper are coated with glue by means of a glueing unit. Thereafter, the corrugated paper, still engaged with the corrugated configuration of the central corrugating cylinder and coated with glue on the ridges thereof, is bonded to the liner and is passed, together with the latter, between the central corrugating cylinder and a pressure cylinder, and then it is moved away from the central corrugating cylinder and out of the corrugating unit.

The production of a satisfactory single-faced corrugated board having regular and uniform characteristics, with complete bonding of the liner to the corrugated paper, is a basic requirement to obtain a double face corrugated board having high mechanical characteristics. For this purpose, the corrugated paper or medium must be held adhering to the corrugated surface of the central corru= gating cylinder during the formation of the corrugation until it is associated with the liner, and practically, therefore, over a central corrugating cylinder sector defined between the area of contact with the inlet corru= gating cylinder and the area of contact with the pressure cylinder.

The adherence engagement between the corrugated paper and the corrugated surface of the central corrugating cylinder has been achieved heretofore by mechanical means formed by comb-like finger members, which entailed, however, considerable operative costs, high maintenance costs and poor quality of the single-faced corrugated board (non-

-uniform corrugations, i.e. corrugations with flutes of different heights, unsatisfactory glueing, distorted corrugations, and other inconveniences). Specifically, the finger members create non-glued stripes on the single--faced corrugated board, with resulting detriment to the mechanical characteristics of the corrugated board.

As a consequence, corrugating units with no fingers, called suction corrugating units (or fingerless units), have been developed wherein the close adherence contact between the corrugated paper and the corrugated surface of the central corrugating cylinder is effected pneumatically by suction effect, i.e. by means of depression below atmospheric pressure. Suction is exerted either through peripheral suction holes, notches or channels in the central corrugating cylinder, communicating with internal suction conduits in the body of said cylinder, or through peripheral annular grooves formed in the corru= gating cylinder and communicating either with discrete suction conduits or with a vacuum chamber located outside of the central corrugating cylinder, that is at the sector thereof opposite to that which is being engaged by the corrugated paper. This suction engagement of the corrugated paper or medium against the corrugated surface of the central corrugating cylinder reduces the possibility of formation of irregular corrugations, i.e. of high and low corrugations, and ensures, therefore, a more satisfactory bonding (glueing) of the single-faced corrugated board, compared with that ensured by the corrugating units equipped with comb members. The use of suction to effect a close

adherence to the corrugated paper against the surface of the corrugating cylinder, however, has some drawbacks. Specifically, the central corrugating cylinder must be provided with peripheral suction holes, notches or channels communicating, in some embodiments, with suction conduits formed in the body of said cylinder. The construction of this type of suction corrugating cylinders is extremely complicated and expensive. Moreover, the suction holding of the corrugated core board against the surface of the central corrugating cylinder through peripheral holes, notches or channels thereof, causes a non-uniform holding between said corrugated paper and central corrugating cylinder until a condition of uniform pressure differential between the board and cylinder is reached. Located between the vacuum pump and the corrugated board are various elements, such as conduits, holes, notches, channels and the like, which cause load losses, whereby said suction ensures a relatively poor adherence of the corrugated board against the central corrugating cylinder, even under high vacuum conditions. Therefore, the corrugated paper will not adhere thoroughly uniformly and evenly against the surface of the central corrugating cylinder. This drawback is emphasized in particular operative conditions, such as in case of very porous papers, worn cylinders, during the acceleration and deceleration steps, and the like. In order to eliminate these drawbacks, the suction corrugating units must be operated with high vacuum values so as to take into account said strong losses, which, however, causes the paper (especially if of poor substance) to be sucked and more or less drawn into the peripheral

suction holes, notches or channels of the central corru= gating cylinder. This deformation of the corrugated core board or medium can cause the formation of non-glued stripes in the single-faced corrugated board, and can also progressively wear the sharp edges of suction peripheral holes, notches or channels of the central corrugating cylinder. Moreover, in the suction corrugating units, impurities in the ambient atmosphere and in papers cause obstructions and deposits in the suction system and reduce the efficiency of said system with resulting further load losses, which entails frequent and complicated cleaning and maintenance operations. Finally, in case of suction corrugating units, the width of the papers should pre= ferably be the same as the length of the cylinders to avoid exposing peripheral suction holes, notches or channels of the central corrugating cylinder, thus losing vacuum.

This invention aims to eliminate said drawbacks of the heretofore known corrugating units, both of the suction fingerless type and of the finger type.

This object is achieved by the invention in that the adherence of the corrugated paper or medium against the corrugated surface of the corrugating cylinder is caused by an air cushion rather than by suction, i.e. it is caused by a slight air pressure, just higher than atmospheric pressure, applied to the outside surface of the corrugated paper or medium, on the side opposite to that which is being engaged with the corrugating cylinder.

The air cushion applied to the outside surface of the corrugated wore board at the central corrugating cylinder, contemplated an air cushion zone followed by a controlled air decompression section, and is applied to the central corrugating cylinder active side, i.e. the side of this cylinder where the corrugated paper or medium is coated with glue and is then bonded to the liner.

The air cushion, according to the invention, preferably acts against the central corrugating cylinder sector included between the nip of said central corrugating cylinder and inlet corrugating cylinder and the region where the liner board is bonded to the corrugated paper coated with glue.

Preferably, according to a further characteristic of the invention, the liner board is approached and pre--associated to the corrugated paper, i.e. it is just approached with slight contact with the corrugated paper by means of a suitable approaching roll, located between the glueing unit and the pressure cylinder, and the air cushion presses on the corrugated paper at the central corrugating cylinder sector included between the nip of the central corrugating cylinder and inlet corrugating cylinder and the region where the liner board is approached to the corrugated paper by means of said approaching roll, while downstream of said region, to the region where the liner board is bonded to the corrugated board, the single--faced corrugated paper being formed is acted upon by the air cushion in a decompression ambient. A progressive and

controlled evacuation of the air entrapped between the corrugated core board and the liner board is thus obtained.

According to the invention, to obtain a satisfactory and uniform engagement of the corrugated board against the central corrugating cylinder by means of air cushion, the invention provides means to maintain the interstice between the corrugated surface of the central corrugating cylinder and the corrugated paper in communication with the atmosphere, thus permitting a controlled evacuation of the air seeped through the board. Said means for communication with the atmosphere may be formed, for example, by shallow annular grooves suitably spaced on the central corrugating cylinder.

With respect to suction corrugating units known heretofore, the unit according to the invention has the advantage of using a central corrugating cylinder of conventional type, that is without holes or internal ducts. Therefore, the manufacturing and maintenance costs of these corrugating cylinders are greatly reduced, while avoiding the drawbacks of both the corrugating units equipped with comb members, and the corrugating units of the suction type with no comb members. Moreover, as in the corrugating unit according to the invention the air cushion applied onto the corrugated core board is fed into a zone which is followed by a successive controlled decompression section, partly defined by said corrugated board, there will be, practically, no appreciable pressure drop between the air cushion acting on the board and the

air fed to, and present at, the air cushion zone followed by a controlled decompression section, so that the entire pressure differential between the air cushion in said zone and the ambient atmosphere is exploited to maintain the corrugated paper adhering against the corrugated surface of the central corrugating cylinder, with a negligible loss and in any operative contidion. Under these operative conditions, a satisfactory and uniform corrugation of the paper will be obtained, thus avoiding the formation of corrugations of different heights, even with papers of poor substance and resistance, and achieving the production of corrugated board having high mechanical characteristics Moreover, an optimum efficiency of the heat exchange between the central corrugating cylinder and the corrugated paper, with resulting energy saving in the operation of the corrugating unit. The improved heat exchange efficiency also permits higher temperatures of the corrugated paper and/or lower temperatures of the cylinders and/or higher rates of speed when operating with boards of good substance and permits to operate, in this instance, even at the setting temperature of the adhesive. Since in the corrugating unit according to the invention the air cushion applied to the outside surface of the corrugated core board is distributed uniformly over the entire length of the respective sector of the central corrugating cylinder, for a same total bearing force there will be a smaller specific pressure at the very narrow peripheral channels and, therefore, a negligible drawing effect of corrugated paper into said channels, whereby a uniform and continuous glueing will be obtained between

the corrugated paper and the liner board at the ridges of all corrugations and over the entire length of said ridges, even at the very narrow peripheral channels. A further advantage of the corrugating unit according to the invention is that the latter enables the production of single-faced corrugated board of any reduced length with respect to the length of the corrugating cylinders, because the air cushion applied to the outside surface of the corrugated core board grants the constant adherence contact of said board against the corrugated surface of the central corrugating cylinder, regardless of the width of papers. The annular air discharge grooves formed in the central corrugating cylinder and designed to establish the communication to atmosphere from the interstice between the corrugating cylinder and corrugated paper, are very narrow and in small number. Therefore, even when operating with papers of reduced length that expose some of the annular grooves of the central corrugating cylinder, any leaks and flowrate drops at the means generating the air cushion are negligible and do not affect the good adherence contact of the corrugated papers against the corrugated surface of the central corrugating cylinder. In the corrugating unit according to the invention, the correct operation of the unit and the good adhering contact of the corrugated paper against the corrugating cylinder surface are not affected by any impurity either in the ambient atmosphere or of the board material. Specifically, any impurity of the board material is ejected into the atmosphere, whereby the corrugating unit according to the invention is to be ragarded as self-cleaning, thus reducing

considerably the maintenance operation and shut-down drawbacks.

An embodiment of the corrugating unit according to the invention aill be described hereinafter as a non--limiting example with reference to the accompanying drawings, wherein:

Figure 1 is a diagrammatic cross-sectional view of a corrugating unit according to the invention;

Figure 2 is a fragmentary longitudinal sectional view, on a larger scale, of the sealing means at one end of a corrugating cylinder;

Figure 3 is a fragmentary longitudinal sectional view, on a larger scale, of the sealing means at one end of an approaching roller and of an associated press roller.

With reference to the drawings, the corrugating unit of an apparatus for manufacturing corrugated board comprises an inlet corrugating cylinder 1, a central corrugating cylinder 2 and a press cylinder 3, all rotating as indicated by the arrows. The peripheral surfaces of the two corrugating cylinders 1 and 2 have a corrugated configuration, and these cylinders 1 and 2 are in mesh similarly to gear wheels.

The paper 4 to be corrugated is fed to the inlet corrugating cylinder 1 in the direction indicated by the arrow and is passed around said cylinder and between the inlet corrugating cylinder 1 and central corrugating cylinder 2 and is thus corrugated. The corrugated paper will remain on the central corrugating cylinder 2 until it has just passed the pressure cylinder 3, as will be described hereinafter. At the sector of the central corrugating cylinder 2, included between the inlet corrugating cylinder 1 and pressure cylinder 3, a glueing unit 5 is provided comprising a glue-containing tank 6 and a glueing roller 7 dipping into the tank 6 and cooperating with the central corrugating cylinder 2 to apply the glue, withdrawn from the tank 6, to the ridges of the corrugations of the corrugated paper. The glueing roller 7 cooperates with a metering roller 8 provided with a doctor blade 9.

Located between the glueing roller 7 and pressure roller 3 is an approaching roller 10 cooperating with the central corrugating cylinder 2 and a pressure roller 11. The liner board 12 is fed to the approaching roller 10 after passing around the pre-heating cylinders 13 and between the approaching roller 10 and associated pressure roller 11. The approaching roller 10 places the liner 12 on the glue-coated ridges of the corrugated paper 4 supported on the central corrugating cylinder 2, without exerting any bonding pressure, that is with only a slight contact, thus effecting a mere pre-bonding between the corrugated paper 4 and the liner board 12.

The corrugated paper 4 and liner board 12 slightly contacted thereon by the approaching roller 10 are then passed, thus associated and pre-bonded with each other, between the central corrugating cylinder 2 and the pressure cylinder 3, where they are definitively glued and bonded. The single-faced corrugated board 14 thus obtained then moves away from the central corrugating cylinder 2 and moves forward as indicated by the arrow towards other units, to be submitted to further operations.

At the sector of the central corrugating cylinder 2, which is included between the inlet corrugating cylinder 1 and the approaching roller 10, the corrugated paper is kept closely and uniformly adhering to the shaped (corru= gated) surface of the central corrugating cylinder 2 by means of an air cushion applied to the outside surface of said corrugated paper, i.e. to the surface thereof facing away from the corrugating cylinder 2. For this purpose, on the side of the central corrugating cylinder 2 wrapped by the corrugated paper, an air cushion zone 15 is provided which is followed by a controlled air decompression section, wherein the desired amount of air is fed and kept under control by means of blowers, air pumps, compressors or any other source of compressed air (not shown). Included in this air cushion zone 15 followed by a controlled air decompression section, is also the glueing unit 5.

In the illustrated embodiment, the air cushion zone 15 followed by the controlled air decompression section is located between two side walls 115 and is

defined by a front wall 215 and a bottom wall 315, and on the upper side and the opposite side from the front wall 215, by a roller 16 and the inlet corrugating cylinder 1, central corrugating cylinder 2, approaching roller 7 and associated pressure roller 11. The roller 16 is coated with anti-adherence rubber resisting to high temperature and is pressed against the inlet corrugating cylinder 1, while the airtight closure between the roller 16 and front wall 215 of the air cushion zone 15 followed by a controlled air decompression section, is ensured by a doctor blade 17. The airtightness between the two metallic corrugating cylinders 1 and 2 is ensured by the meshing engagement of these two cylinders and interposed corrugated paper. The closure between the central corrugating cylinder 2 and approaching roller 10 is ensured by the pre-association or approaching engagement of the corrugated paper and liner. The closure between the approaching roller 10 and respective pressure roller 11 is ensured by the engagement between these two rollers with the interposed liner board 12. The approaching roller 10 is also covered with an anti--adherence rubber coating resisting to high temperatures. The pressure roller 11 is made of metal, and the closure between this roller 11 and the back wall 315 of the air cushion zone 15 follwed by a decompression section is ensured by a doctor blade 18.

To reduce air escape from the air cushion zone 15 followed by a controlled decompression section, at the ends of the various cylinders and rollers 1,2,7,8,10,11,16, any suitable radially and/or axially acting means may be

provided, designed to accommodate any thermal expansion of said cylinders, rollers and/or respective shafts. Figures 2 and 3 show two embodiments of axially-acting sealing means provided at an end of the inlet corrugating cylinder 1 (Figure 1) and of the approaching and pressure rollers (Figure 3). In the embodiment of Figure 2, compressed against the end face of the corrugating cylinder 1, around the shaft 101 of said cylinder 1, is an annular seal 19 carried by a sealing ring 20 axially slidable within a cylindrical extension 122 of a ring member 22 fixed to the side wall 23. The sealing ring 20 is axially urged by springs 24 toward the end of the corrugating cylinder 1 and is guided by bolts or stems 25 fixed to said ring 20 and slidably passing through holes in the ring member 22 and side wall 23. A seal 21 is provided between the slidable ring 20 and the fixed cylindrical extension 122.

In a similar manner, as shown in Figure 3, sealing rings 20 are axially urged against the end faces of the approaching roller 10 and pressure roller 11, either with or without interposed annular front seals. The sealing rings 20 are slidably arranged each in a cylindrical extension 122 of a ring member 22 fixed to the side wall 23 around a bearing 26 supporting the shaft of the respective cylinder, as shown for the shaft 110 of the approaching cylinder 10. Again, the slidable rings 20 are axially urged by springs 24 against the ends of the respective rollers 10, 11, i.e. they resiliently yield axially and are fixed to bolts or stems 25 slidably guided

through holes in the ring member 22. Seals 21 are interposed between the slidable rings 20 and respective cylindrical extensions 122.

To permit the access to the corrugating cylinders 1, 2 and to the pressure cylinder 3, the two side walls 115 and the front wall 215 and bottom wall 315 of the air cushion zone followed by a controlled decompression section 15, may be arranged on a carriage 27, while the glueing roller 7, metering roller 8, sealing roller 16, approaching roller 10 and respective pressure roller 11 may be supported by the side walls 115 or remain in a pre-set position on the main body of the corrugating unit. The carriage 27 is slidable on rails 28 arranged transversely of the corrugating cylinders 1 and 2 and pressure cylinder 3, whereby it may be moved away from these cylinders 1,2,3 together with the rollers 7,8,10,11,16. The leaking of air between the side walls 115 of the carriage-supported assembly 15 and the fixed walls of the apparatus may be easily reduced by means familiar with those skilled in the art.

Between the approaching roller 10 and pressure cylinder 3, that is between the zone of pre-engagement of the corrugated paper with the liner and the zone of definitive glueing and bonding thereof, the single-faced corrugated board being formed passes through a decompression section 29 communicating with the atmosphere. In this section 29, the adherence of the corrugated paper against the corrugated surface of the central corrugating cylinder

1 is ensured by the liner board which is placed over said corrugated paper. Therefore, in the decompression section 29, any air enclosed and entrapped within the corrugations of the corrugated board upon said pre-engagement step at the approaching roller 10 is ejected and its pressure is reduced quickly and continuously to atmospheric pressure. Therefore, at the sector of the central corrugating cylinder 2, corresponding to the decompression section 29, a progressive and uniform approach will be effected between the corrugated paper and liner board, which will be already associated with each other at the nip between the central corrugating cylinder 2 and pressure cylinder 3, and the latter then causes the final bonding thereof.

The central corrugating cylinder 2 is provided with shallow annular grooves 102 to establish the communi= cation between the atmosphere and the interstice between the surface of the central corrugating cylinder 2 and the corrugated board adhering against said surface, and to permit the continuous evacuation of the air existing between the central corrugating cylinder 2 and the corrugated board and of the air seeping through said board at the air cushion zone 15. The amount of air seeping through the corrugated board and evacuated to the atmosphere, anyway, is relatively small, whereby said annular grooves 102 may be very narrow and in small number.

Of course, the invention is not limited to the embodiment here shown and described, but broad changes and modifications may be made thereto, especially of

constructional nature and within the scope of technical and operational equivalents, without departing from the basic principle set forth above and claimed hereinafter.

CLAIMS

1) A corrugating unit for an apparatus for manufacturing corrugated board, comprising two cooperating corrugating cylinders, namely an inlet cylinder and a central cylinder, both having a corrugated configuration, the paper to be corrugated being passed therebetween and the corrugated paper coming out from the pair of corru= gating cylinders being kept in engagement with the corrugated configuration of the central corrugating cylinder, where the tips or ridges of the corrugated paper receive glue by means of a glueing unit, whereafter the corrugated paper or medium is associated with a liner and is passed together with it between the central corrugating cylinder and a pressure cylinder cooperating therewith, characterized in that the contact of the corrugated paper with the corrugated surface of the corrugating cylinder is determined by an air cushion applied to the outside face of the corrugated paper, i.e. to the face thereof opposite to that which is being engaged with the central corrugating cylinder.

2) A corrugating unit according to claim 1, characterized in that said air cushion applied to the outside face of the corrugated paper on at least the sector of the central corrugating cylinder included between the contact zone of said central corrugating cylinder with the inlet corrugating cylinder and the area where the liner is placed on the glue-coated corrugated paper.

3) A corrugating unit according to claim 1, characterized in that said liner is applied to the corru= gated paper and pre-bonded thereto, i.e. it is merely approached with a slight contact to the corrugated paper, by means of a suitable approaching roller arranged between the glueing unit and the pressure cylinder, and the air cushion is applied to the corrugated paper at the central corrugating cylinder sector included between the contact zone of the central corrugating cylinder with the inlet corrugating cylinder and the area where the liner is approached to the corrugated paper by means of the approaching roller, while downstream of said zone to the area where the corrugated paper is bonded to the liner, i.e. at the central corrugating cylinder sector included between the approaching roller and pressure cylinder, the single-faced corrugated board being formed is processed at atmospheric pressure in a decompression ambient (zone).

4) A corrugating unit according to claim 1, characterized in that on the side of the central corru= gating cylinder with which the corrugated paper is in contact, there is provided an air cushion zone followed by a controlled decompression section extending from at least the contact area of the central corrugating cylinder and inlet corrugating cylinder to the area of pre-bonding of the corrugated board and liner by means of an approaching roller, and said air cushion zone is connected to means for continuously feeding into into said zone air at a pressure slightly higher than atmospheric pressure.

5) A corrugating unit according to claim 4, characterized in that the air cushion zone followed by a controlled decompression section is situated within a structure enclosing the glueing unit and connected to the inlet corrugating cylinder by means of a roller and doctor blade, and to the approaching roller by means of pressure roller and a doctor blade.

6) A corrugating unit according to claim 5, characterized in that the structure enclosing the air cushion zone followed by a controlled decompression section may be moved away from the inlet and central corrugating cylinders and from the pressure cylinder, preferably but not necessarily together with the sealing roller, approaching roller and respective pressure roller.

7) A corrugating unit according to claim 1, characterized by means for maintaining the communication from the interstice between the corrugated surface of the central corrugating cylinder and corrugated paper to the atmosphere with continuous evacuation of the paper dust and consequent cleaning effect.

8) A corrugating unit according to claim 1, characterized by the fact that the system fro holding the corrugated paper by means of an air cushion generates an optimum plasticization (conditioning) of the paper to be corrugated due to the formation of condensate generated by the contact of the ambient air with the heated surfaces of the corrugating and press cylinders having at their interior superheated steam at 14/16 Ate (180°C).

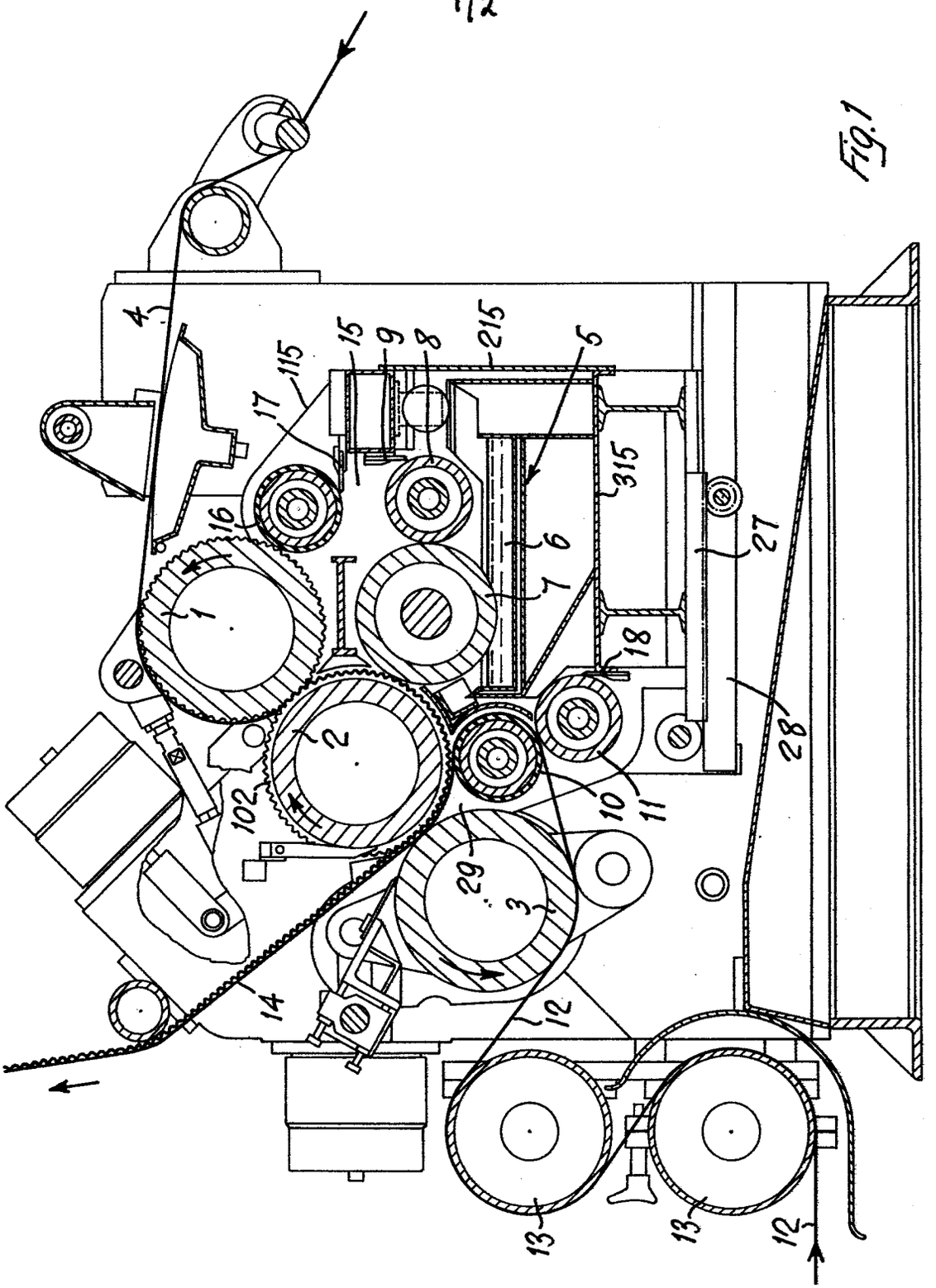

Fig.1

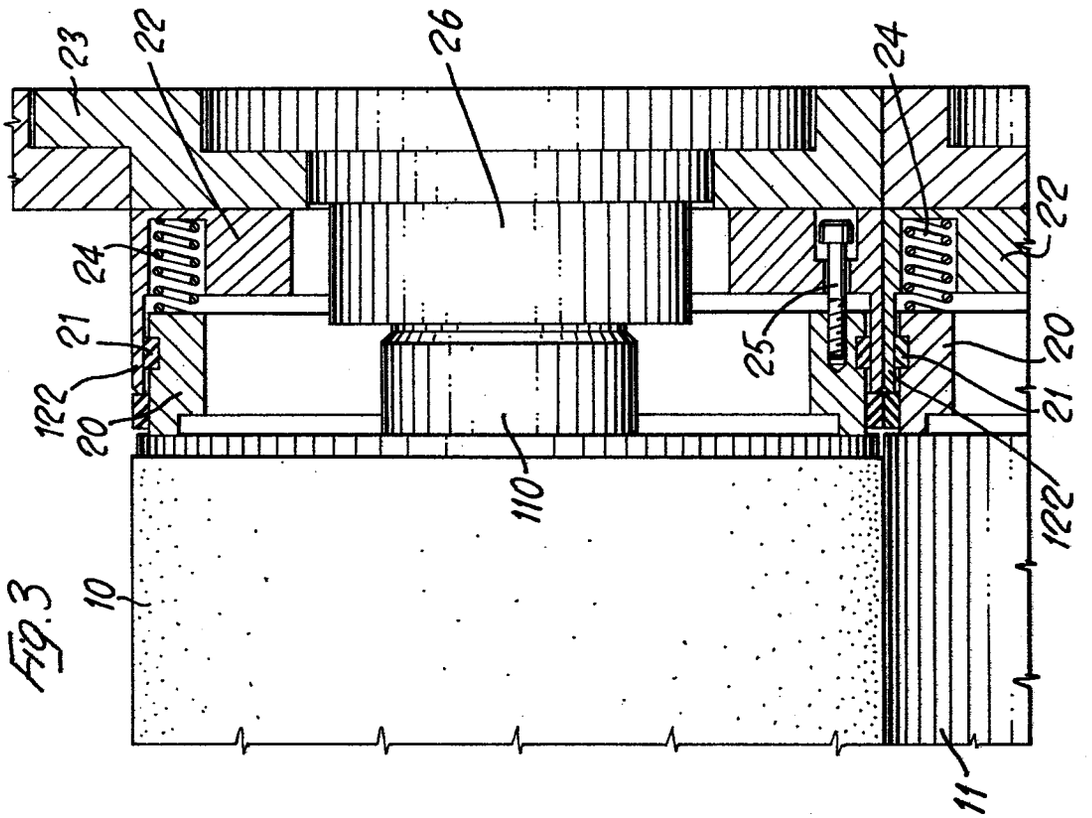
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Fig. 3

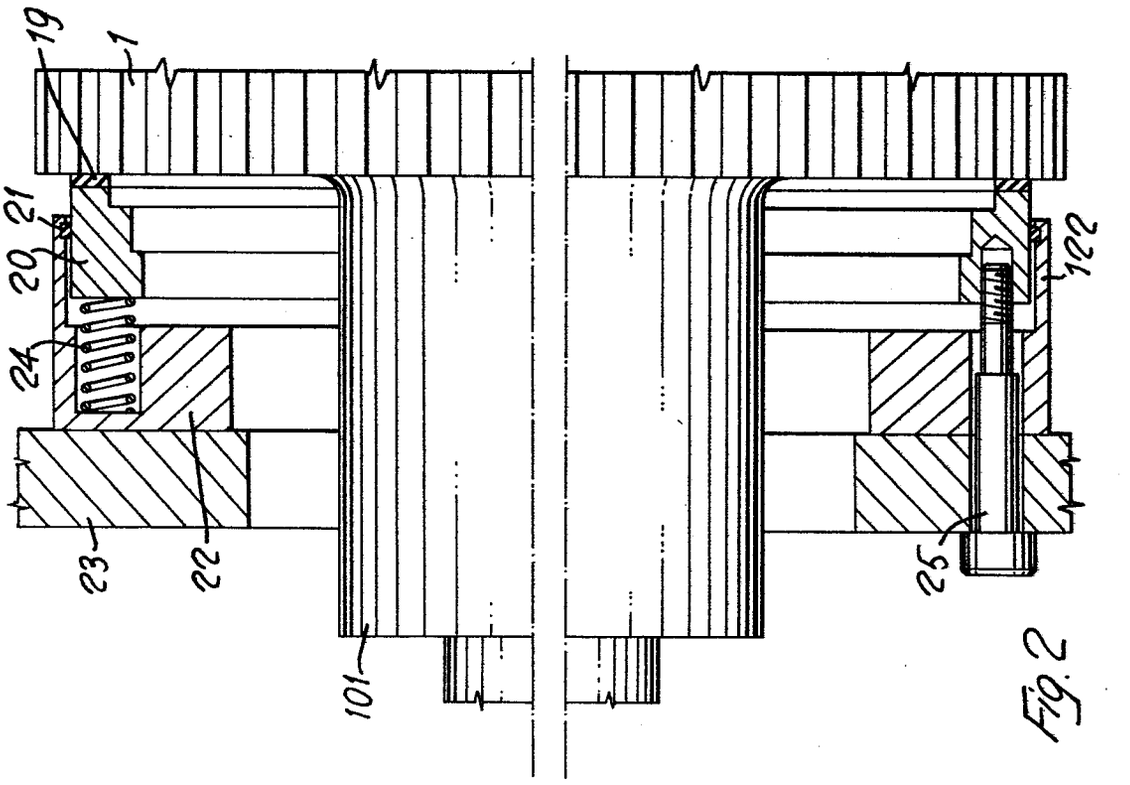
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Fig. 2

European Patent Office

EUROPEAN SEARCH REPORT

Application number 0092079

EP 83103173.7

DOCUMENTS CONSIDERED TO BE RELEVANT

Category	Citation of document with indication, where appropriate, of relevant passages	Relevant to claim	CLASSIFICATION OF THE APPLICATION (Int. Cl. ³)
X	DE - A - 2 935 677 (NIHON ELECTRONIC) * Totality * ----	1-4	B 31 F 1/28

TECHNICAL FIELDS SEARCHED (Int. Cl. ³)

B 31 F 1/00

The present search report has been drawn up for all claims

Place of search	Date of completion of the search	Examiner
VIENNA	30-06-1983	HOFMANN

CATEGORY OF CITED DOCUMENTS

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