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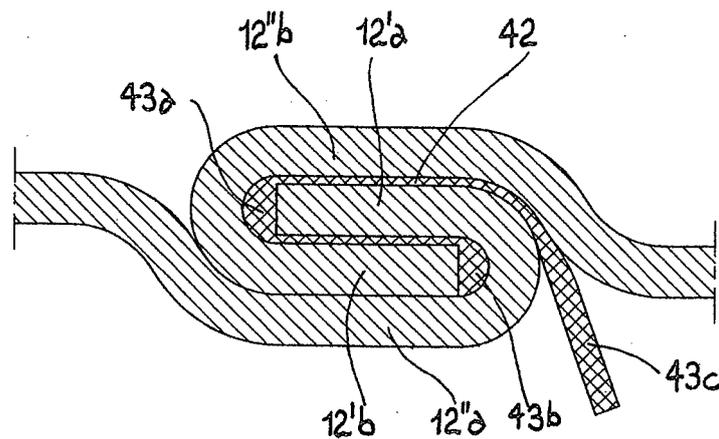
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(54) **Method and apparatus for manufacturing watertight, corrugated metal pipes from a strip of metal sheet, and watertight, corrugated metal pipe manufactured by such method**

(57) Longitudinal corrugations are formed on a strip (12) of metal sheet by successive passages between counterposed corrugating barrels (20, 22) having alternated, circumferential ridges (24, 26) on their outer surfaces. The opposite, longitudinal lips (12a, 12b) of the strip (12) are bent in opposite directions, then the strip (12) of metal sheet is coiled into a helical shape, whereby the opposite, longitudinal lips (12a, 12b) overlap laterally. Before the opposite, longitudinal lips (12a, 12b) are

crimped together between counterposed crimping rollers (38, 39), a rubber gasket (42) is fitted to one of the opposite longitudinal lips (12b). The gasket has a bent profile capable of embracing the longitudinal lip at least partially, whereby the material of the gasket (42), by effect of the crimping pressure, is reduced in thickness and deformed plastically at least in certain areas (12'a, 12'a, 12'b, 12'b) of the longitudinal lips (12a, 12b) which are biased against each other by the crimping action.



**Fig. 8**

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## Description

**[0001]** The present invention relates to a method for manufacturing watertight, corrugated metal pipes from a strip of metal sheet, as well as to an apparatus for carrying out such method and to a watertight, corrugated metal pipe resulting from the method.

**[0002]** It is well known in the art to manufacture corrugated metal pipes up to 3-4 meters in diameter from a strip of metal sheet, e.g., a galvanized steel sheet 1.2 to 3.5 mm thick and about 200 mm to 1200 mm wide. A flat strip, which is generally unwound from a coil, is firstly made corrugated, i.e., undulated, by successive passages between couples of counterposed, corrugating barrels having alternated circumferential ridges on their outer surface. A series of corrugations (e.g., four corrugations) extending in the longitudinal direction are so formed on the strip of steel sheet. The corrugated strip is then coiled into a helical shape by a set of coiling rollers, and the opposite, longitudinal lips of the strip are crimped together by a couple of counterposed, crimping rollers, so that a helically corrugated pipe is formed. Thereafter, the opposite ends of the corrugated pipe may be sawed, e.g., at right angles to the axis of the pipe. Depending on the specific application, the opposite ends of the pipe can be closed by peripherally welded steel covers.

**[0003]** For some applications, e.g., for production of ducts or tanks for piping/containing/collecting fluids, pipes of the above type are required to have watertight capabilities.

**[0004]** In case of small junctions, a reliable watertightness may be achieved by welding. However, welding all along the crimped lips of the pipe would be too expensive and time consuming.

**[0005]** Another known method for providing corrugated metal pipes with watertightness capabilities consists of inserting a rubber string gasket having a circular profile between the longitudinal lips of the strip which are crimped together. In detail, the gasket is positioned in the gap defined between the edge of one lip and the inner surface of the opposite lip, which is U-bent to embrace the other lip during crimping. The diameter of the gasket is conventionally chosen a little larger than the thickness of the steel sheet, e.g., a 4 mm gasket for a steel sheet 2.5 mm thick, so that the gasket in its operative configuration is subject to a slight elastic deformation.

**[0006]** Unfortunately, the above method has some drawbacks.

**[0007]** First of all, the string gasket is liable to twist and/or distort during its insertion between the longitudinal lips of the steel sheet, before the latter are crimped together. Consequently, the string gasket may easily slip outside of its seat (i.e., the above-defined gap) and tear during crimping, resulting in uneven and unreliable watertightness along the crimped longitudinal lips of the pipe.

**[0008]** Moreover, even when the gasket is correctly positioned in its seat, the contact surface between the gas-

ket and the wall of the pipe is relatively small, resulting in limited watertightness capability of the pipe.

**[0009]** Therefore, it is a main object of the present invention to provide a method for manufacturing watertight, corrugated metal pipes having considerably improved performance in terms of watertightness capabilities, without substantial increase in the manufacturing costs and in the machining times.

**[0010]** It is another object of the invention to provide an apparatus for carrying out the above method, as well as a watertight, corrugated metal pipe resulting from the method.

**[0011]** The above object and other advantages, which will become apparent from the following description, are achieved by a method having the features recited in claim 1, while the dependent claims state other advantageous, though secondary features of the invention.

**[0012]** The invention will be now described in more detail with reference to a few preferred, non-exclusive embodiments shown by way of non limiting example in the attached drawings, wherein:

Fig. 1 is a view in side elevation of a first station of the apparatus according to the invention for manufacturing watertight, corrugated metal pipes;

Fig. 2 is a view in cross section of Fig. 1 along line II-II;

Fig. 3 is a view in cross section of Fig. 1 along line III-III;

Fig. 4 is a plan view showing a second station of the apparatus for manufacturing watertight, corrugated metal pipes according to the invention;

Fig. 5 is a view in side elevation of the second station of Fig. 4;

Figs. 6, 7 and 8 are views in transverse cross section of the opposite longitudinal lips of a steel sheet processed with the method according to the invention, in respective three successive configurations;

Fig. 9 is a view similar to Fig. 6, showing a first alternative embodiment of the invention;

Fig. 10 is a view similar to Fig. 6, showing a second alternative embodiment of the invention;

Fig. 11 is a view similar to Fig. 6, showing a third alternative embodiment of the invention.

**[0013]** An apparatus for manufacturing watertight, corrugated metal pipes from a strip of metal sheet, e.g., a galvanized steel sheet 3 mm thick and 1 meter wide, is illustrated in Figs. 1-5. Of course, other conventional metallic materials can be used, e.g., an aluminum-coated steel sheet or a magnesium-coated steel sheet 1.2 to 3.5

mm thick.

**[0014]** With initial reference to Figg. 1-3, in a manner known per se strip 12 is unwound from a coil 14 mounted on a motorized hub 16 which is rotatably supported on an elongated frame 18 of the apparatus at an upstream end thereof. Strip 12 is made corrugated (i.e., undulated) in a corrugating station 19 by successive passages between couples of horizontal, counterposed corrugating barrels which are rotatably supported by frame 18 with their axes lying at right angles to the longitudinal direction of strip 12 unwinding from coil 14. Each couple comprises a lower corrugating barrel such as 20 and an upper corrugating barrels such as 22 which engage strip 12 on respective opposite sides thereof. Corrugating barrels 20, 22 have alternated, circumferential rounded ridges 24, 26 on their outer surfaces, the ridges on one barrel of the couple being at least partially inserted between the ridges on the other barrel in the couple. As a result, a series of corrugations (e.g., four corrugations) extending in the longitudinal direction are conventionally formed on strip 12. The distance between the axes of the corrugating barrels 20, 22 of the couple is gradually reduced from the first couple to the last couple in the succession, whereby strip 12 is deformed gradually. To this purpose, upper corrugating barrels 22 are supported at their opposite ends by respective slides such as 27, the vertical position of which is manually adjustable by respective screw mechanisms such as 28. Corrugating barrels 20, 22 are driven to rotate by motor means M via a gearbox G.

**[0015]** As shown in Fig. 3, the corrugating barrels 20, 22 of the last couple are provided, at their opposite ends, with bending means consisting of circumferential bending ridges 30a, 30b and 32a, 32b which cooperate to bend outer longitudinal lip 12a at right angles downwards and inner longitudinal lip 12b at right angles upwards.

**[0016]** A shearing unit (not shown) may be conventionally provided upstream of the succession of corrugating barrels 20, 22 for shearing strip 12 transversely, in case the latter deviates from the correct longitudinal direction while unwinding from coil 14.

**[0017]** Having now particular reference to Figs. 4, 5, strip 12 processed by the series of corrugating barrels 20, 22 is then coiled into a helical shape in a coiling station 34, with the opposite, longitudinal lips 12a, 12b of strip 12 which overlap laterally. Coiling station 34 comprises two sets of coiling rollers 36a, 36b arranged at different levels which engage the lower face of strip 12, and a third set of coiling rollers 36c which engage the upper face of strip 12 between the first two sets. The three sets of coiling rollers are all supported by a second frame 37.

**[0018]** In coiling station 34, the opposite, longitudinal lips 12a, 12b of strip 12 are also crimped together by a couple of counterposed, crimping rollers 38, 39. One of the crimping rollers (lower crimping roller 38 in Fig. 5) is biased towards the other one (upper crimping roller 39) by a hydraulic actuator 40 which may be operated for adjusting the crimping pressure.

**[0019]** As shown in Figs. 4, 5, according to the present

invention, before the opposite, longitudinal lips 12a, 12b of strip 12 overlap and are crimped together, a rubber gasket 42 having a substantially U-bent profile is fitted to one of the opposite longitudinal lips 12a, 12b, preferably inner longitudinal lip 12b which is bent upwards; accordingly, by effect of the crimping pressure, gasket 42 is drastically reduced in thickness, with plastic deformation of the material of the gasket at least in certain areas of the longitudinal lips which are biased against each other by the crimping action, as will be disclosed in more detail below.

**[0020]** Fig. 6-8 show longitudinal lips 12a, 12b of strip 12 in successive configurations during crimping. In Fig. 6, rubber gasket 42 is fitted to inner longitudinal lip 12b of strip 12, while outer longitudinal lip 12a is still far away from overlapping it. In Fig. 7, outer longitudinal lip 12a overlaps inner longitudinal lip 12b, but the crimping action has not begun yet and rubber gasket 42 is still undeformed. In Fig. 8, the opposite longitudinal lips 12a, 12b are crimped together and gasket 42 is consequently crushed and deformed plastically. In more detail, gasket 42 is substantially reduced to a thin film mainly in the flat areas 12'a, 12"a, 12'b, 12"b of longitudinal lips 12a, 12b which are biased against each other by the crimping action. The gaps defined between the edge of one lip and the inner surface of the opposite lip which is U-bent about the first lip are also filled with the material of the gasket in 43a, 43b, as shown in Fig. 8. The exceeding rubber 43c projecting outside of the lock seam can be subsequently cut.

**[0021]** The thickness of the rubber gasket (before crimping) is preferably in the range 0.5 to 2.5 mm. In the above described embodiment, a squared U-shaped rubber gasket 42 is used, with the outer leg 42a of the U-shape which is longer than the inner leg 42b. For example, for a steel sheet 3 mm thick, a rubber gasket 1.5 mm thick and 6 mm wide can be used, with a longer leg 12 mm long and a shorter leg 0.9 mm long.

**[0022]** As shown in Fig. 5, rubber gasket 42 is unrolled from a coil 44 which is rotatably supported with horizontal axis upstream of coiling station 34 by a third frame 45. Rubber gasket 42 is guided to engage longitudinal lip 12b of strip 12 by guiding means. The latter consist of a hollow guiding arm 46, in which the gasket is slidably inserted, and which is also supported by third frame 45.

**[0023]** It should be understood that the profile of the rubber gasket can be extensively varied within a wide range of profiles either matching or not with the profile of the steel sheet, provided that the bent profile of the gasket is capable of embracing the longitudinal lip of the strip at least partially; for instance, gaskets 142 and 242 as shown in Figs. 9 and 10, which respectively have a substantially U-bent profile with diverging legs 142a, 142b and a V-bent profile, as well as gaskets 342 as shown in Fig. 11, which have a substantially L-bent profile, will fall within the scope of this invention.

**[0024]** The crimping pressure, which can be adjusted by hydraulic actuator 40, is preferably set in the range 0

to 9000 psi, more preferably 5000 to 6000 psi.

[0025] The material of the gasket is preferably polychloroprene. However, other natural or synthetic rubbers having similar mechanical properties can be used, such as nitrile rubber.

[0026] The opposite ends of the pipe can be conventionally cut, e.g., at right angles to the axis of the pipe, and, depending on the specific application, they can be closed by steel covers welded peripherally, in a manner known per se.

[0027] It has been found in practice that the method according to the invention achieves the above-declared scope of considerably improving the performance of the corrugated metal pipes in terms of watertightness capabilities. In fact, rubber gasket 42, subject to the crimping pressure, is plastically deformed and reduced to a film having a thickness of only a few tens of micron or less, so that it fills all the recesses and any gaps defined between the surfaces of the two longitudinal lips crimped together.

[0028] Furthermore, the increase in the manufacturing costs is relatively small because it is essentially limited to the cost of the rubber gasket.

[0029] The processing time also is unaffected, since the rubber gasket can be continuously fed to the steel strip regardless of the feeding speed of the latter.

[0030] In addition, it has been found that the mechanical strength of the seam lock is also substantially unaffected by the insertion of the rubber gasket, whereby the resulting pipe thoroughly complies with the standards and regulations to be observed in this technical field.

[0031] A few preferred embodiments of the invention have been described herein, but of course many changes may be made by a person skilled in the art within the scope of the claims. For example, although it is easier to fit the rubber to inner longitudinal lip 12b, of course, it could also be fitted to outer longitudinal lip 12a. Generally, all the method steps both preceding and following the insertion of the gasket could be carried out in a different manner. For instance, the corrugating station and the coiling station could be configured in a different manner, according to different methods of forming the corrugations and coiling the strip which are well known per se. For instance, instead of forming the corrugations by reducing the distance between the axes of the corrugating barrels step by step, with other known methods is the number of circumferential ridges that is increased step by step. Of course, also the number of passages between counterposed corrugating rollers could be reduced or increased, depending on various factors, such as the thickness of the steel sheet.

## Claims

1. A method for manufacturing watertight, corrugated metal pipes, comprising the steps of:

forming longitudinal corrugations on a strip (12) of metal sheet by at least one passage between counterposed corrugating barrels (20, 22) having alternated, circumferential ridges (24, 26) on their outer surfaces,

bending the opposite, longitudinal lips (12a, 12b) of said strip (12) in opposite directions, coiling said strip (12) of metal sheet into a helical shape, whereby said opposite, longitudinal lips (12a, 12b) overlap laterally, crimping said opposite, longitudinal lips (12a, 12b) together between counterposed crimping rollers (38, 39),

### **characterized in that**

before crimping said opposite, longitudinal lips (12a, 12b) together, a rubber gasket (42) is fitted to one of said opposite longitudinal lips (12b), said gasket having a bent profile capable of embracing said longitudinal lip at least partially, whereby the material of the gasket (42), by effect of the crimping pressure, is reduced in thickness and deformed plastically at least in certain areas (12'a, 12"a, 12'b, 12"b) of said longitudinal lips (12a, 12b) which are biased against each other by the crimping action.

2. The method of claim 1, **characterized in that** said rubber gasket has a substantially U-bent profile.
3. The method of claim 2, **characterized in that** said rubber gasket has a squared, U-bent profile, with one leg (42a) of the U-shape longer than the other leg (42b).
4. The method of any of claims 1 to 3, **characterized in that** said rubber gasket has a squared, U-bent profile with diverging legs (142a, 142b).
5. The method of claim 1, **characterized in that** said rubber gasket has a substantially V-bent profile (242).
6. The method of claim 1, **characterized in that** said rubber gasket has a substantially L-bent profile (342).
7. The method of claim 1 or 2, **characterized in that** the thickness of said rubber gasket, before crimping said opposite, longitudinal lips (12a, 12b) together, is in the range 0.5 to 2.5 mm.
8. An apparatus for carrying out the method of claim 1, **characterized in that** it comprises:

a corrugating station (19), in which longitudinal corrugations are formed on a strip (12) of metal sheet by at least one passage between counterposed corrugating rollers (20, 22) having al-

ternated, circumferential ridges (24, 26) on their outer surfaces,  
 bending means (30a, 32a, 30b, 32b) adapted to bend the opposite, longitudinal lips (12a, 12b) of said strip (12) of metal sheet in opposite directions, 5  
 a coiling station (34) adapted to coil said strip (12) of metal sheet into a helical shape, with said opposite, longitudinal lips (12a, 12b) overlapping laterally, 10  
 a couple of counterposed crimping rollers (38, 39) adapted to crimp said opposite, longitudinal lips (12a, 12b) together,  
**characterized in that** it comprises guiding means (46) adapted to fit a rubber gasket (42) 15  
 to one of said opposite longitudinal lips (12b) upstream of said crimping station (34) in a guided manner, said rubber gasket having a bent profile capable of embracing said longitudinal lip at least partially, whereby the material of the rubber gasket (42), by effect of the crimping pressure, is reduced in thickness and deformed plastically at least in certain areas (12'a, 12"a, 12'b, 12"b) of said longitudinal lips (12a, 12b) which are biased against each other by the crimping action. 20  
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9. The apparatus of claim 8, **characterized in that** said guiding means comprises a hollow guiding arm (46) in which said rubber gasket (42) is slidably inserted. 30

10. A watertight, corrugated metal pipe manufactured by the method of claim 1, comprising a corrugated strip of metal sheet coiled into a helical shape and having its opposite, longitudinal lips (12a, 12b) crimped together, **characterized in that** a rubber gasket (42) is crushed between said opposite longitudinal lips (12b), the material of the rubber gasket being reduced in thickness in a plastically deformed configuration with respect to its original configuration, at least in certain areas (12'a, 12"a, 12'b, 12"b) of said longitudinal lips (12a, 12b) which are biased against each other by crimping action. 35  
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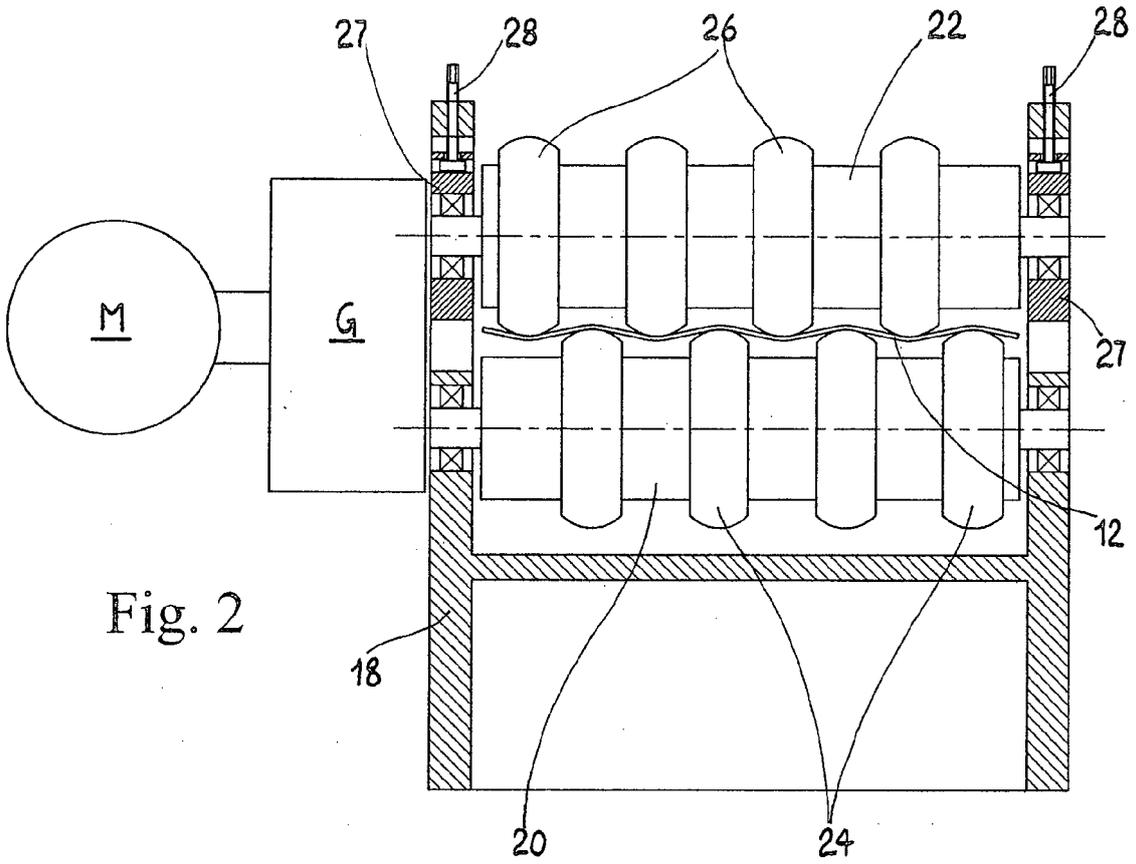


Fig. 2

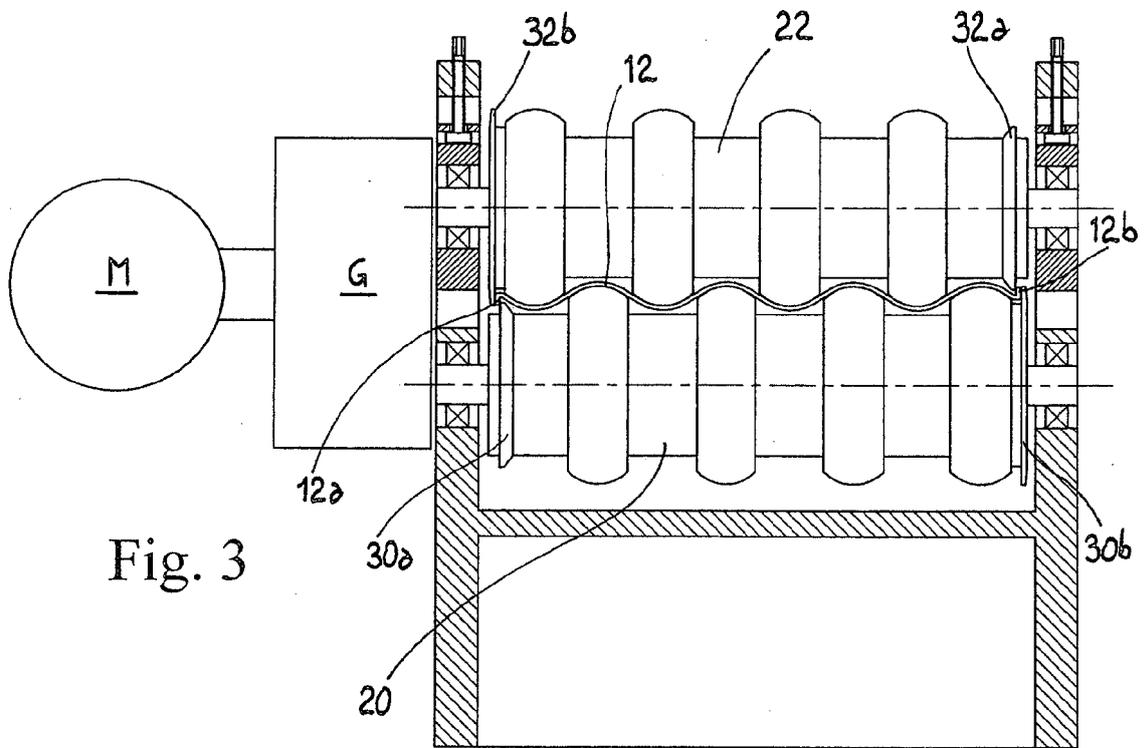


Fig. 3

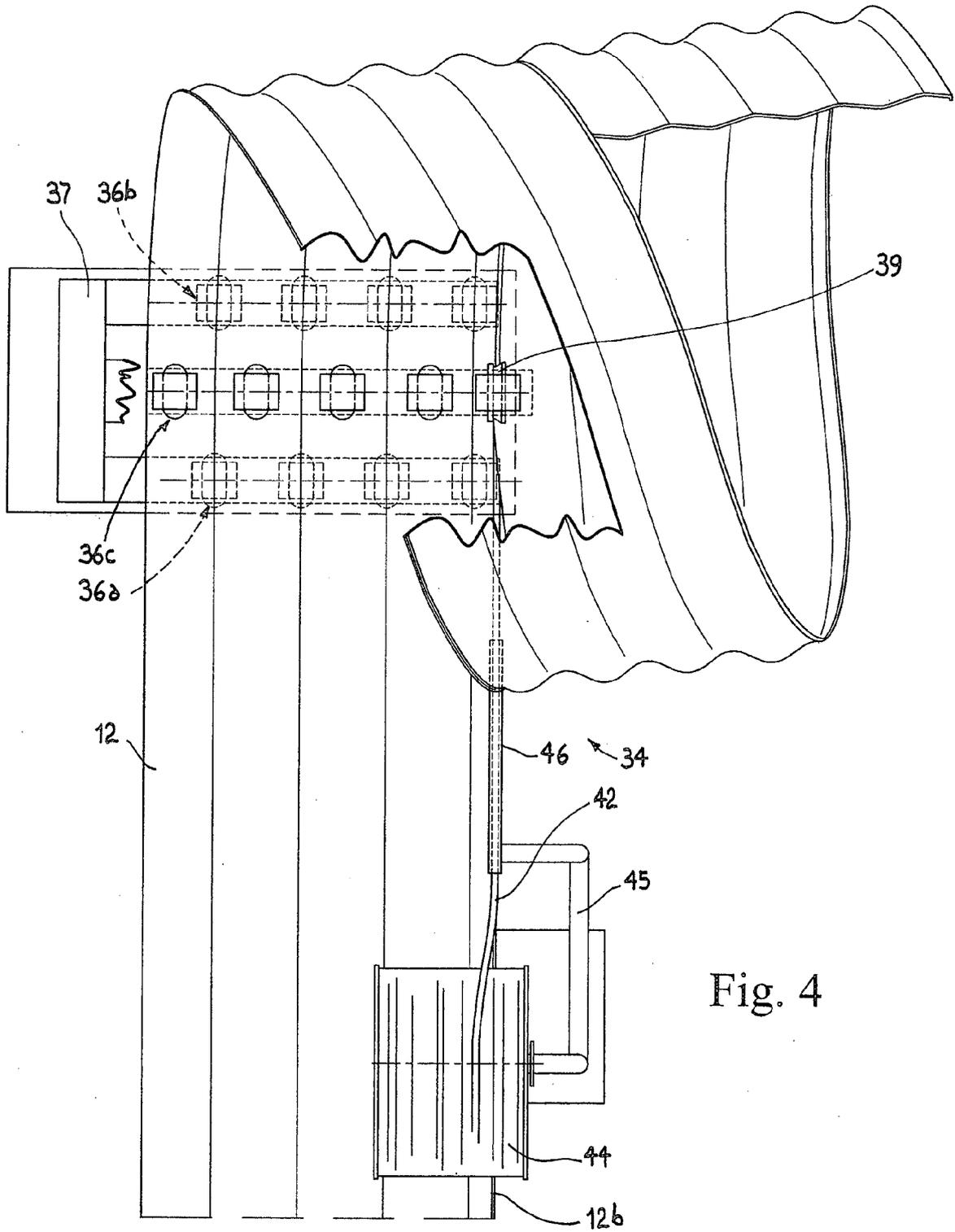


Fig. 4

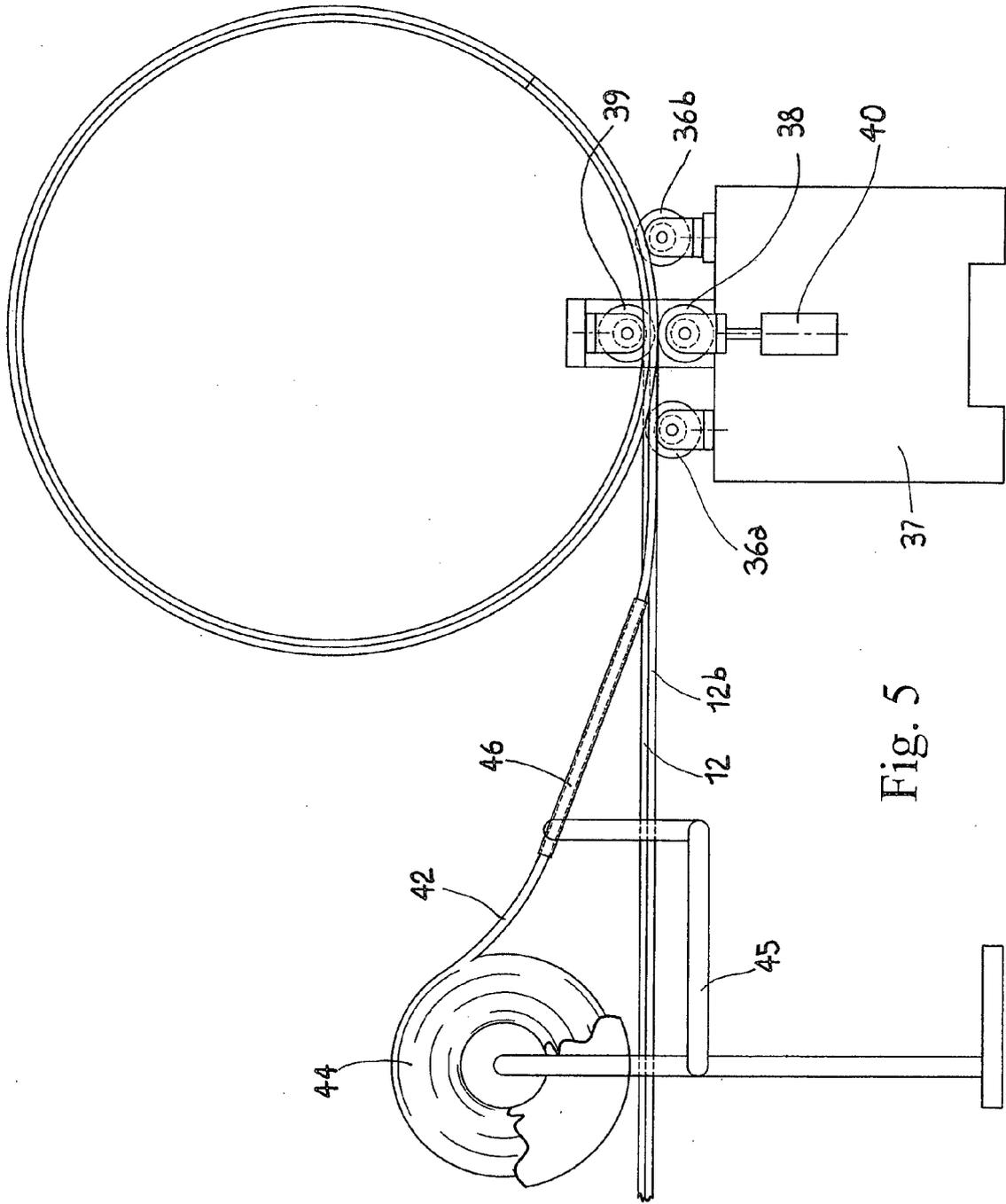


Fig. 5

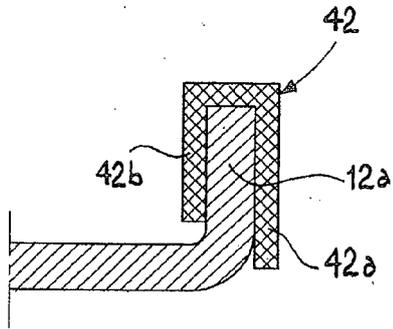


Fig. 6

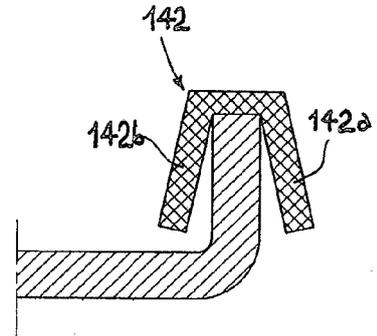


Fig. 9

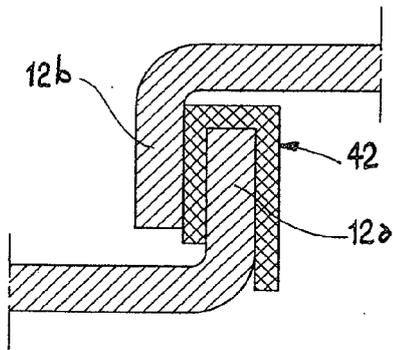


Fig. 7

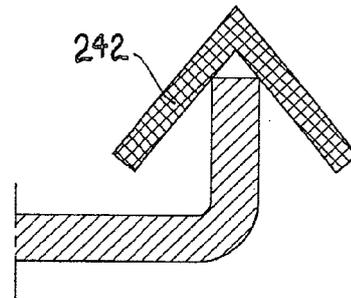


Fig. 10

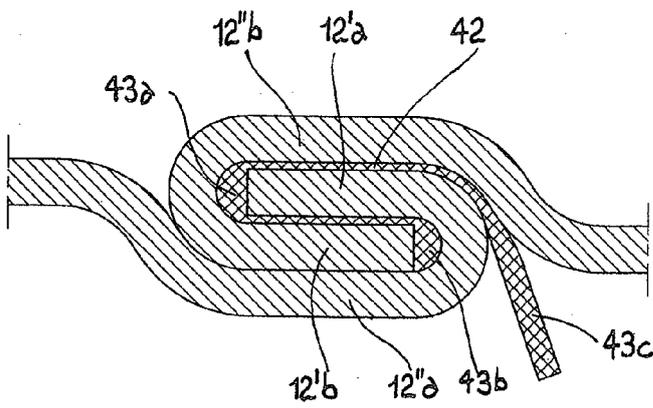


Fig. 8

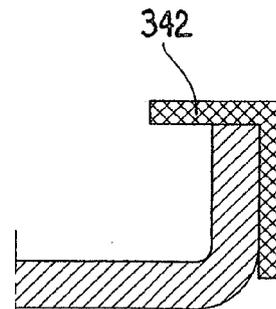


Fig. 11



EUROPEAN SEARCH REPORT

Application Number  
EP 13 00 5356

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DOCUMENTS CONSIDERED TO BE RELEVANT			
Category	Citation of document with indication, where appropriate, of relevant passages	Relevant to claim	CLASSIFICATION OF THE APPLICATION (IPC)
A	GB 1 080 770 A (PACIFIC ROLLER DIE COMPANY INC) 23 August 1967 (1967-08-23) * page 8, lines 61-124; figure 11 * -----	1,8	INV. B21C37/12
X	FR 996 496 A (GUNNAR AXEL STRÖMBERG; RALPH ENGELBREKT ERICSON) 19 December 1951 (1951-12-19) * column 1, paragraph 2-4; figure 2 * -----	10	
X	US 5 720 095 A (LENNARTSSON KENNETH [SE]) 24 February 1998 (1998-02-24) * column 5 - paragraph 2; figure 20 * -----	10	
The present search report has been drawn up for all claims			TECHNICAL FIELDS SEARCHED (IPC)
			B21C
Place of search		Date of completion of the search	Examiner
Munich		21 May 2014	Augé, Marc
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**ANNEX TO THE EUROPEAN SEARCH REPORT  
ON EUROPEAN PATENT APPLICATION NO.**

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Patent document cited in search report		Publication date	Patent family member(s)	Publication date
GB 1080770	A	23-08-1967	NONE	
-----				
FR 996496	A	19-12-1951	NONE	
-----				
US 5720095	A	24-02-1998	RU 2152282 C1	10-07-2000
			SE 9501750 A	09-09-1996
			US 5720095 A	24-02-1998
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