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(54) FLEXIBLE CORRUGATED TUBE

(71) I, EMIL SIEGWART of 6, Michael Blatter-Strasse Sulzbach-Neuweiler 6603, Federal Republic of Germany, a citizen of the Federal Republic of Germany, do hereby declare the invention, for which I pray that a patent may be granted to me, and the method by which it is to be performed, to be particularly described in and by the following statement:—

The invention relates to a flexible corrugated tube consisting of a helically wound strip with corrugations extending parallel to its longitudinal direction, in which tube at least one corrugation of one side edge of one turn of the strip lies respectively in at least one corrugation in the other, overlapping side edge of the following turn of the strip, the strip, preferably but not exclusively, being formed of thin sheet metal.

Various types of corrugated tubes of this kind are already known. Nevertheless, they entail the problem of finding the best method of ensuring at the lowest cost that the inter-engaging corrugations of two successive turns of the coil remain in engagement one in the other and do not slip out of one another, which would destroy the connection of the successive turns of strip.

In order to ensure the mutual fixed and non-detachable connection of the inter-engaging corrugations of two successive turns of the strip it has already been proposed that these inter-engaging corrugations should be pressed flat to form seams (US PS 3,858,421).

This known seaming has the consequence that the inside or outside diameter is changed from place to place, since the corrugations pressed flat to form a seam have a substantialy reduced height in the radial direction in comparison with those corrugations of the tube which have not been pressed flat. Above all, however, the flexibility of the corrugated tube is almost completely destroyed in the region of the seams, each of which extends circularly around the tube, and this is frequently found to be disadvantageous since the bendability of the tube is thereby impaired.

A corrugated tube of the kind first mentioned above is also already known in which the crests or troughs of at least two interengaging corrugations are made wider, for the purpose of hooking one into the other, than the distance between the corrugation flanks between the crest and the trough of the corrugations (German Offenlegungsschrift No. 2,235,012). It is true that by this means the overlapping edges of the strip are prevented from being detached from one another in the case of thick-walled tubes, but if a corrugated tube of this kind is made of a very thin, foil-like sheet metal material, or if it has great flexibility so that the interengaging corrugations can be stretched in the direction of the axis of the tube in such a manner that the undercuts are destroyed, there is no absolute certainty that the overlapping edges of the strip will not become detached or pull out of one another.

With a flexible corrugated tube of the kind first described above the invention therefore seeks to prevent in all cases — that is to say even with very thin foil-like sheet metal strips and when the wound sheet metal strips are very flexible — the undesirable slipping out of one another of the inter-engaging corrugations of two neighbouring turns of strip, and therefore their possible detachment from one another.

According to the invention there is provided a flexible corrugated tube consisting of a helically wound thin strip having corrugations extending parallel to the longitudinal direction of the strip, in which

tube at least one corrugation of one side edge of each turn of the strip lies respectively in at least one corrugation in the other overlapping side edge of the following turn of the strip, wherein the crests of the corrugations lying one in the other are locally depressed to the extent of part of the height of the corrugation at least at one point on the periphery of the tube, in such a manner that in the depressed region the inter-engaging crests of two inter-engaging corrugations are wider than the parts of the corrugations situated under the flattened crests, while each neighbouring corrugation adjacent thereto in the longitudinal direction of the tube is not depressed, at least in the region adjoining the depression.

The invention thus has the consequence that in the longitudinal direction extending around the periphery of the tube the crests of two inter-engaging corrugations have parts where the inter-engaging crests have a lower height and greater width, so that in this region the corrugations are deformed two-dimensionally in relation to the neighbouring region. In the transition region there is thus on the one hand a reduction of the height of the corrugations, that is to say a deformation of the corrugations in the radial direction of the tube, and on the other hand a widening of the crests of the corrugations, that is to say a deformation of the corrugations in the axial direction of the tube. This two-dimensional deformation of the corrugations ensures extremely great stability of the inter-engaging corrugations in their deformed region, so that even in the case of a corrugated tube consisting of particularly thin foil-like sheet metal strip the danger of the opening-up of the inter-engaging corrugations hooked to one another, to such an extent that these corrugations might slip one out of the other, is virtually eliminated. Because of the depressions provided only at certain points on the corrugations, the flexibility of the tube is moreover scarcely impaired, particulaly as the neighbouring corrugations next to each depression are not deformed.

In the depression region the cross-section of the corrugations may be roughly in the shape of a push-button or dovetail or rivet-shaped. The depressed corrugation crests may have about half the height of the undeformed corrugation. In a preferred embodiment the depressions of the corrugation crests are punctiform when viewed in the longitudinal direction of the tube. Because of this slight length of the depressions in the tangential direction of the tube wall, great flexibility of the corrugated tubes is ensured. The depressions may be provided only on the crests of the corrugations lying on the outside of the tube or only on the crests situated on the inside of the tube wall.

For the purpose of producing the depressions of the corrugation crests it is possible to use a pressure roller which acts on the outside or the inside of the tube wall, the roller on its periphery having radial projections the length of which corresponds to the desired length of the depression. The pressure roller may be provided on its periphery with grooves into which the corrugations of the wound corrugated tube are inserted, the projections being formed on the base or bottom of the grooves.

One embodiment of a corrugated tube according to the invention and also an embodiment of an aparatus for producing this corrugated tube will now be described, by way of example, with reference to the accompanying drawings in which:—

Figure 1 shows an embodiment of the corrugated tube during the winding process;

Figure 2 is a partial longitudinal section through the finished corrugated tube showing parts of three turns;

Figure 3 is a plan view of a winding apparatus for producing this corrugated tube;

Figure 4 is a cross-section through the pressure roller provided at the strip inlet in the winding apparatus shown in Figure 3.

In the embodiment illustrated in Figures 1 and 2 a corrugated tube is formed from a thin metal strip having corrugations extending parallel to its longitudinal direction by helically winding the strip. The successive turns 1 of the thin metal strip forming the flexible corrugated tube overlap by about half the width of the strip. In their overlapping region the turns 1 of the strip lie with their corrugations one in the other. At determined mutual intervals, in this example every fifth corrugation, depressions 2 on the crests of two inter-engaging corrugations are provided. The depressions are punctiform when viewed in the longitudinal direction of the tube and by the term punctiform is meant that the depressions are very short in the circumferential direction. These depressions are so arranged that in these regions the inter-engaging corrugations have about only half the radial height, while the axial cross-section of the corrugations is given approximately the shape of a push-button, rivet or an inverted trapezium. At both ends of the depressions 2 there are thus two-dimensional modifications 3 of the shape of the inter-engaging corrugations from their normal shape to their depressed shape.

A tube according to Figures 1 and 2 can be produced in a winding apparatus of the kind illustrated by way of example in Figures 3 and 4. This winding apparatus consists of mandrel 4 onto which runs the corrugated strip 5 serving to form the corrugated tube. This strip 5 is wound helically around the mandrel with the aid of a pressure roller 8, reversing roller 7, and guide roller 6, in such a manner that the pitch of the strip turns 1 amounts to approximately half the width of the strip, so that the turns formed overlap to the extent of this width. On their periphery the rollers 6, 7, and 8 are provided with grooves 9 which extend around them and which receive the corrugations of the strip.

The pressure roller 8 is situated at the inlet for the strip 5, the grooves extending around this roller serving to receive the corrugations of the strip.

At certain points on their periphery the grooves 9 in the pressure roller 8 are provided at their bottom with raised portion or projections 10, which have the consequence that the crests of the inter-engaging corrugations of two neighbouring strip turns lying in the grooves are depressed to about half the height of the corrugations, as shown in Figure 2 at two points on two inter-engaging corrugations in each case. The length of the projections is no geater than the width of the grooves.

This depression of parts of the crests of two inter-engaging corrugations leads to local two-dimensional deformation of the corrugation crests. The upward and downward slopes in the corrugation crest which are formed in the peripheral direction of the tube on both sides of the depressions 2 of the corrugation crests, and the modification of the width of the corrugation crest effected at the same time in these regions the crest being wider longitudinally than the base of the depression lead to substantial stiffening and increased stability of shape of the deformed crests of the inter-engaging corrugations, so that even when subjected to a heavy pull in the axial direction of the corrugated tube they will not be detached from one another.

The size of the depression are chosen to give the required qualities for the tube. The length of the depression, measured in the tangential direction may correspond to approximately the height of the undeformed corrugation or may be smaller than the height of the undeformed corrugation. The length may be equal or smaller than the distance between the flanks of two undeformed corrugations. The depressions may be provided, directed radially towards the inside of the tube only on the corrugation crests lying on the outside of the tube or only on the crests lying on the inside of the tube.

WHAT I CLAIM IS:—

1. A flexible corrugated tube consisting of a helically wound thin strip having corrugations extending parallel to the longitudinal direction of the strip, in which tube at least one corrugation of one side edge of each turn of the strip lies respectively in at least one corrugation in the other overlapping side edge of the following turn of the strip, wherein the crests of the corrugations lying one in the other are locally depressed to the extent of part of the height of the corrugation at least at one point on the periphery of the tube, in such a manner that in the depressed region the inter-engaging crests of two inter-engaging corrugations are wider than the parts of the corrugations situated under the flattened crests, while each neighbouring corrugation adjacent thereto in the longitudinal direction of the tube is not depressed, at least in the region adjoining the depression.

2. A corrugated tube according to claim 1, wherein the cross-section of the corrugations in the depressed region has approximately the shape of a push-button or rivet.

3. A corrugated tube according to claim 1 wherein the region of the depressed crest the corrugations have approximately half the height of the undeformed corrugation.

4 A corrugated tube according to claim 1 wherein the depressions of the crests of the corrugations are punctiform in the longitudinal direction of the tube (as defined herein).

5. A corrugated tube according to claim 4 wherein the length of the depression of the crest of the corrugation, measured in the tangential direction of the tube wall, corresponds aproximately to the height of the undeformed corrugation.

6. A corrugated tube according to claim 4, wherein the length of the depression of the crest of the corrugation, measured tangentially to the tube wall, is smaller than the height of the undeformed corrugation.

7. A corrugated tube according to claim 4, 5 or 6, wherein the length of the depression of the crest of the corrugation, measured tangentially to the tube wall, is equal to or smaller than the distance between the flanks of two undeformed corrugations.

8. A corrugated tube according to one or more of claims 1 to 7, wherein the depressions are provided, directed radially towards the inside of the tube, only on the corrugation crests lying on the outside of the tube.

9. A corrugated tube according to one or more of claims 1 to 7, wherein the depressions are provided, directed radially

towards the outside of the tube, only on the corrugation crests lying on the inside of the tube wall.

10. A flexible corrugated tube according to any one of claims 1 to 9, wherein the strip is formed of sheet metal.

11. A flexible corrugated tube substantially as described herein with reference to and as illustrated in Figures 1 and 2 of the accompanying drawings.

12. An apparatus for producing a corrugated tube according to any one of claims 1 to 10 having a pressure roller adapted to act on the inside or the outside of the wound tube, wherein the pressure roller is provided on its periphery with radial projections adapted to locally depress the crests of the corrugations laid one in the other to the extent of part of the height of the corrugation in such a manner that in the depressed region the interengaging crests of two interengaging corrugations are wider than the parts of the corrugation situated under the flattened crests.

13. An apparatus according to claim 12 having a pressure roller provided on its periphery with grooves into which the corrugations of the wound corrugated tube are inserted, wherein the radial projections on the pressure roller are in the grooves.

14. An apparatus according to claim 13, wherein the height of the projections corresponds approximately to half the height of the grooves.

15. An apparatus according to claim 13, wherein the tangential length of the projections is no greater than the width of the grooves.

16. Apparatus for producing a corrugated tube the apparatus being substantially as described herein with reference to, and as illustrated in, Figures 3 and 4 of the accompanying drawings.

JENSEN & SON,
Agents for the Applicants,
8, Fulwood Place,
High Holborn,
London WC1V 6HG.
Chartered Patent Agents.

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Fig.1

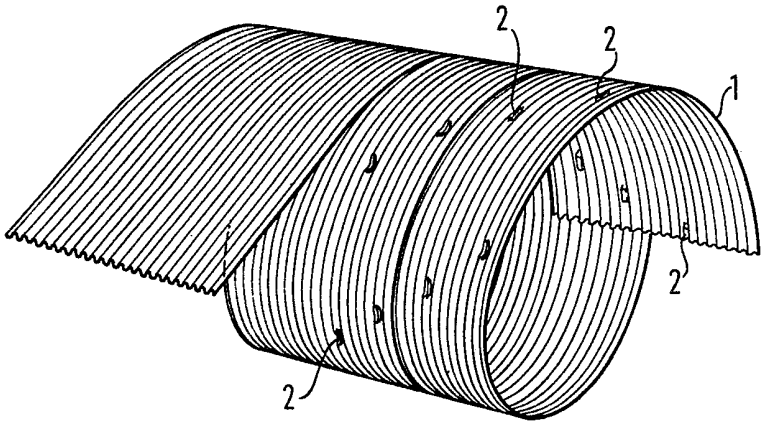
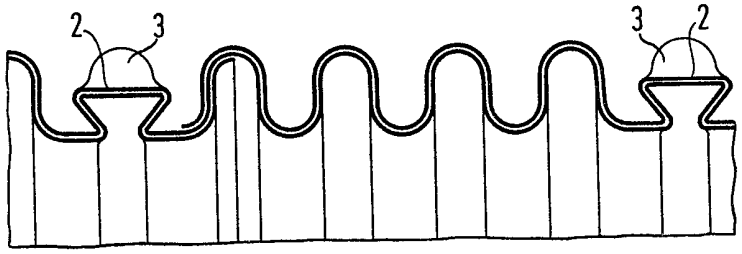


Fig.2



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Sheet 2

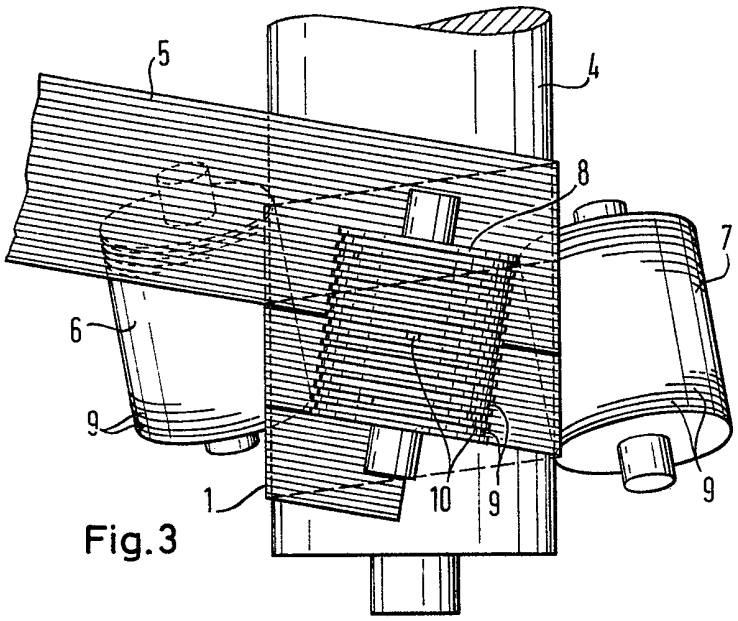

Fig.3

Fig.4