

PATENT SPECIFICATION

DRAWINGS ATTACHED

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COMPLETE SPECIFICATION

Improvements in or relating to Hollow Tubes

I, ARISTOVOULOS GEORGE PETZETAKIS, a Greek citizen, of 105 Kremou Street, Kallithea, Athens, Greece, 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:—

This invention relates to hollow tubes and more particularly to such tubes made of synthetic resin material and suitable for use as hosepipes.

In one aspect the present invention provides a seamless flexible tube made of a first material, incorporating in its wall a spiral core of a second material which spiral core is fully embedded and inseparably fused in the wall of the tube making an integral part with the tube itself, said second material having a higher mechanical strength than said first material, which is more plastic and softer than the second material.

By "inseparably fused" it is meant that any attempt to separate the materials by force will damage one of the materials, usually tearing the said first material, before breaking the bond between them.

In another aspect the invention provides a method of making a flexible tube which comprises continuously extruding a core of a first material, simultaneously extruding a second material which is more plastic and softer than said first material around said core, said first material having a higher mechanical strength than said second material, subjecting the materials to sufficient pressure to form a firm bond between them, and extruding the materials through a rotating nozzle so as to wind the emerging material on itself so that the softer material fuses to form a continuous flexible tube incorporating a spiral core of the stronger material.

In a further aspect the invention provides apparatus for forming an extrusion of tubular

or spiral form which comprises a stationary head having two inlets for the entry of two materials, the one of which leads through a nozzle into the centre of a first common channel through which the materials may pass, a rotatable head having a second channel which joins the first channel so that at their junction the axis of each channel coincides with the axis of rotation of the rotatable head, the second channel ending in a nozzle through which material from the second channel emerges, the nozzle being displaced from the axis of rotation so that material pushed through the nozzle will be wound on itself in spiral manner.

The invention will be more readily understood from the following description of embodiments thereof, given by way of example only, reference being made to the accompanying drawing which shows a cross section through an extruding apparatus and tube according to the invention.

The apparatus is designed for the simultaneous extrusion of two separate thermoplastic materials. A fixed head 2 has two inlets 3 and 4, one of which 3 leads through channel 3a and circular-section nozzle 5 into the centre of a first common channel 4b.

Inlet 4, through channel 4a, leads also into the common channel 4b which is situated in a second fixed member 1. Inside the fixed member 1 is a rotatable member 7 driven by a co-operating toothed wheel 10 which is connected through a shaft 9 to a variable speed motor (not shown). The member 7 is rotatable about the axis X—X¹.

The rotatable member 7 has a channel 4c which connects with the channel 4b so that at their connecting point 18 the axis of each channel coincides with the axis X—X¹. Obviously, because of the rotation, the two channels must be of circular cross-section at point 18.

Channel 4c leads into a nozzle 7a integral

[Price 4s. 6d.]



Channel

with the rotating member 7, which nozzle is displaced a distance r from the axis $X-X'$, so that as member 7 is rotated the nozzle describes a circular track radius r around that axis.

Corresponding to this circular track is a gap 15 formed between circular dies 12 and 13.

In operation a mechanically strong material such as rigid PVC is ~~formed~~ forced through inlet 3 and nozzle 5, under continuous pressure from an extruder, into the centre of a stream of softer material, such as soft plasticised PVC which moves along the channel 4b coming from inlet 4.

The materials are pushed together through the channel 4b and as they are forced to pass through narrow channels they are subjected to high pressure and are firmly bonded together to form a hard core inseparable when cooled from the surrounding layer of softer, more plastic material.

The materials so bonded are forced, under the continuous pressure exerted from the extruders, to pass from channel 4b of the stationary head to channel 4c of the rotating head and through channel 4c are led to nozzle 7a from which they are ejected into gap 15 between the dies 12 and 13 while the nozzle is at the same time rotating.

The correlation between the rotational speed of the nozzle and the extrusion speed of the materials through it is such that the nozzle, during its rotation, deposits continuously on its circular track a strip of the bonded materials which is wound on itself in spirals, so that the still hot, plastic, surrounding portion of the strip which is formed of the softer material fuses to form a continuous wall without a seam, thus giving a circular section hollow tube 17 whose wall 16 incorporates a strengthening spiral core 6 and which tube is pushed forward by the material coming continuously from the nozzle.

It is, therefore, obvious that by this method the two materials, which are of different hardness and plasticity, are strongly bonded together in the initial phase of the process under high pressure and temperature, while at the last phase of the process only the sealing of the homogeneous and soft covering material is involved, which is easily achieved by insignificant pressure.

The covering of the hard core with the softer material at the initial phase of the process aims also at facilitating the passage of the harder core through the narrow channels, since the softer material interposes between the hard core and the metallic inner surfaces of the channels acting as a lubricant and thus conveying with it the hard core. This makes it possible that the strengthening spiral core may be made of very hard materials which are normally very difficult to extrude. Also, by elongating

the narrow channel in the rotating head and by adjusting the corresponding displacement of the nozzle to various distances from its axis of rotation, hoses of different and very large diameters can be obtained.

The method of forming this tube, by which the strong core is firmly bonded approximately in the centre of the softer wall, gives a tube of great strength using a small quantity of materials. While the reinforcing spiral core increases the resistance of the tube at its circumferential direction (where the greatest forces act), it does not affect (owing to the aforesaid perfect bonding of the two materials) its resistance at its longitudinal direction, and as the spiral core forms an integral part with the wall of the hose, it becomes obvious that by this method, in the last analysis, the tube is reinforced without using more material in volume than that which would be required for the production of a similar but not reinforced tube of the same size.

The fact that the passage of the materials from the stationary head into the rotating one is effected through channels of small circular cross-section eliminates the problems of tightness and friction at the contact of the two heads, although the materials passing through this section are subjected to high pressure. As a result of the above a simple and sturdy construction of the apparatus carrying out this process is possible.

The thickness of the spiral core, its pitch, as well as the thickness of the wall of the tube can be varied according to the specific requirements of the types of tube which are required and also to the properties of the materials used. According to the elasticity of the softer material hoses of different and very high flexibility can be obtained, in which the embodied spiral core of the hard material makes the tube equally strong to withstand high internal pressures or vacuums.

It is obvious that this tube, after it has been formed, can be further processed, as for instance by coating externally or lining internally the tube with other protective materials, etc.

Instead of synthetic resin material, there may be used any thermoplastic or thermosetting materials and mixtures thereof, natural and synthetic rubbers and their mixtures with synthetic resins and generally any material that can be extruded.

WHAT I CLAIM IS:—

1. A seamless flexible tube made of a first material, incorporating in its wall a spiral core of a second material which spiral core is fully embedded and inseparably fused in the wall of the tube making an integral part with the tube itself, said second material having a higher mechanical strength than said first material, which is more plastic and softer than the second material.



with the rotating member 7, which nozzle is displaced a distance r from the axis $X-X'$, so that as member 7 is rotated the nozzle describes a circular track radius r around that axis.

Corresponding to this circular track is a gap 15 formed between circular dies 12 and 13.

In operation a mechanically strong material such as rigid PVC is formed through inlet 3 and nozzle 5, under continuous pressure from an extruder, into the centre of a stream of softer material, such as soft plasticised PVC which moves along the channel 4b coming from inlet 4.

The materials are pushed together through the channel 4b and as they are forced to pass through narrow channels they are subjected to high pressure and are firmly bonded together to form a hard core inseparable when cooled from the surrounding layer of softer, more plastic material.

The materials so bonded are forced, under the continuous pressure exerted from the extruders, to pass from channel 4b of the stationary head to channel 4c of the rotating head and through channel 4c are led to nozzle 7a from which they are ejected into gap 15 between the dies 12 and 13 while the nozzle is at the same time rotating.

The correlation between the rotational speed of the nozzle and the extrusion speed of the materials through it is such that the nozzle, during its rotation, deposits continuously on its circular track a strip of the bonded materials which is wound on itself in spirals, so that the still hot, plastic, surrounding portion of the strip which is formed of the softer material fuses to form a continuous wall without a seam, thus giving a circular section hollow tube 17 whose wall 16 incorporates a strengthening spiral core 6 and which tube is pushed forward by the material coming continuously from the nozzle.

It is, therefore, obvious that by this method the two materials, which are of different hardness and plasticity, are strongly bonded together in the initial phase of the process under high pressure and temperature, while at the last phase of the process only the sealing of the homogeneous and soft covering material is involved, which is easily achieved by insignificant pressure.

The covering of the hard core with the softer material at the initial phase of the process aims also at facilitating the passage of the harder core through the narrow channels, since the softer material inter-poses between the hard core and the metallic inner surfaces of the channels acting as a lubricant and thus conveying with it the hard core. This makes it possible that the strengthening spiral core may be made of very hard materials which are normally very difficult to extrude. Also, by elongating

the narrow channel in the rotating head and by adjusting the corresponding displacement of the nozzle to various distances from its axis of rotation, hoses of different and very large diameters can be obtained.

The method of forming this tube, by which the strong core is firmly bonded approximately in the centre of the softer wall, gives a tube of great strength using a small quantity of materials. While the reinforcing spiral core increases the resistance of the tube at its circumferential direction (where the greatest forces act), it does not affect (owing to the aforesaid perfect bonding of the two materials) its resistance at its longitudinal direction, and as the spiral core forms an integral part with the wall of the hose, it becomes obvious that by this method, in the last analysis, the tube is reinforced without using more material in volume than that which would be required for the production of a similar but not reinforced tube of the same size.

The fact that the passage of the materials from the stationary head into the rotating one is effected through channels of small circular cross-section eliminates the problems of tightness and friction at the contact of the two heads, although the materials passing through this section are subjected to high pressure. As a result of the above a simple and sturdy construction of the apparatus carrying out this process is possible.

The thickness of the spiral core, its pitch, as well as the thickness of the wall of the tube can be varied according to the specific requirements of the types of tube which are required and also to the properties of the materials used. According to the elasticity of the softer material hoses of different and very high flexibility can be obtained, in which the embodied spiral core of the hard material makes the tube equally strong to withstand high internal pressures or vacuums.

It is obvious that this tube, after it has been formed, can be further processed, as for instance by coating externally or lining internally the tube with other protective materials, etc.

Instead of synthetic resin material, there may be used any thermoplastic or thermosetting materials and mixtures thereof, natural and synthetic rubbers and their mixtures with synthetic resins and generally any material that can be extruded.

WHAT I CLAIM IS:—

1. A seamless flexible tube made of a first material, incorporating in its wall a spiral core of a second material which spiral core is fully embedded and inseparably fused in the wall of the tube making an integral part with the tube itself, said second material having a higher mechanical strength than said first material, which is more plastic and softer than the second material.



2. A tube according to claim 1 in which the spiral core is located approximately centrally in the wall of the tube.

3. A tube according to claim 1 or 2 in which the spiral core is of circular cross section.

4. A tube according to any one of claims 1 to 3, in which said first material is soft plasticised PVC.

5. A tube according to any one of claims 1 to 4 in which said second material is rigid PVC.

6. A flexible tube substantially as described herein with reference to the accompanying drawing.

7. A method of making a flexible tube which comprises continuously extruding a core of a first material, simultaneously extruding a second material which is more plastic and softer than said first material around said core, said first material having a higher mechanical strength than said second material, subjecting the materials to sufficient pressure to form a firm bond between them, and extruding the materials through a rotating nozzle so as to wind the ~~emerging~~ material on itself so that the softer material fuses to form a continuous flexible tube incorporating a spiral core of the stronger material.

8. A method according to claim 7 in which the extruded materials are guided to the rotating nozzle through guide channels and the second material acts as a lubricant for the first material in said channels.

9. A method according to claim 7 or 8 in which the two materials are firmly bonded together into a strip by means of their simultaneous extrusion through a common extrusion head before being pushed through the rotating nozzle.

10. A method according to any one of claims 7 to 9 in which the rotating nozzle, during its rotation, ejects and deposits continuously on a circular track a strip of the two materials already firmly bonded and which strip is wound on itself in spiral manner, so that the still hot, plastic, surrounding portion of the strip, which is formed of the softer material fuses to form the tube.

11. A method according to any one of

claims 7 to 10 in which the core is caused to be located approximately centrally in the wall of the tube.

12. A method according to any one of claims 7 to 11 in which the core is formed of circular cross-section.

13. A method according to any one of claims 7 to 12 in which said first material is rigid PVC.

14. A method according to any one of claims 7 to 13 in which the said second material is soft plasticised PVC.

15. A method of making a flexible tube substantially as described herein with reference to the accompanying drawings.

16. A flexible tube made by a method according to any one of claims 7 to 15.

17. Apparatus for forming an extrusion of tubular or spiral form which comprises a stationary head having two inlets for the entry of two materials, the one of which leads through a nozzle into the centre of a first common channel through which the materials may pass, a rotatable head having a second channel which joins the first channel so that at their junction the axis of each channel coincides with the axis of rotation of the rotatable head, the second channel ending in a nozzle through which material from the second channel emerges, the nozzle being displaced from the axis of rotation so that material pushed through the nozzle will be wound on itself in spiral manner.

18. Apparatus according to claim 17 including dies situated beneath the nozzle and defining a circular ring section gap corresponding to the path of rotation of the nozzle.

19. Apparatus substantially as described herein with reference to the accompanying drawing.

20. A flexible tube according to any one of claims 1 to 6 made by means of an apparatus according to any one of claims 17 to 19.

A. A. THORNTON & CO.,
Chartered Patent Agents,
Northumberland House,
303/306, High Holborn, W.C.1,
For the Applicant.

