

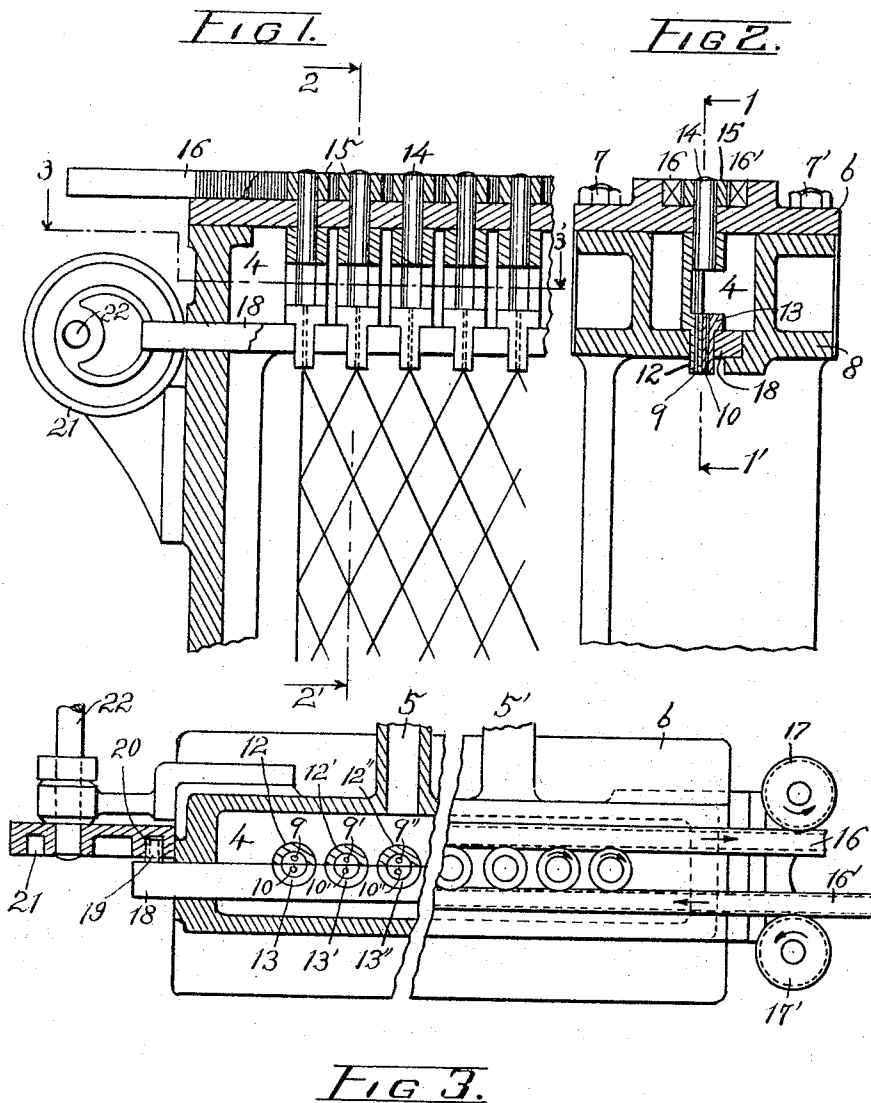
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METHOD AND APPARATUS FOR CONTINUOUSLY SPINNING A PLASTIC NET

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METHOD AND APPARATUS FOR CONTINUOUSLY SPINNING A PLASTIC NET

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The present invention relates to a method and apparatus for continuously forming a net from plastic material by extruding filaments of plastic material through nozzles and by connecting the extruded filaments to each other to produce a structure in the form of a net.

Considerable difficulties are encountered in forming nets from extruded plastic filaments. One difficulty resides in properly interconnecting the filaments so as to form the interconnections of the net, and the other difficulty resides in properly maintaining the cross-section of the filaments, especially during interconnecting and subsequently separating the filaments from each other. Various attempts have been made to overcome these difficulties and according to one known method, the filaments extruded from independent nozzles are caused in the moment of their extrusion to adhere to each other to form the intersections of a net, whereas according to another known method the nozzle ends through which the filaments are extruded are alternately brought together and separated to form the meshes of the net. In the first-mentioned method, the cross-section of the filaments can be made completely round and such nets are therefore very suitable for fishing nets and in other uses where strong resistance due to water or other currents is not desired. However there are considerable difficulties in obtaining strong and stable interconnections of the filaments at the intersections. In the second known method there are considerable difficulties encountered during separation of the nozzle ends from each other in parting the viscous liquid material extruded through the nozzles. Another difficulty encountered with the second method is to maintain a uniform cross-section of the filaments.

It is an object of the present invention to provide for a method and apparatus for continuously manufacturing nets from extruded plastic filaments while avoiding the difficulties above described.

It is a further object of the present invention to provide for a method and apparatus for continuously forming a net from extruded filaments in which the filaments forming the net structure are perfectly connected to each other at the intersection of the net structure and in which the filaments in the final net structure will have substantially the same cross-section at which they are extruded.

With these objects in view, the method of manufacturing a net from plastic material mainly comprises the steps of extruding a plurality of pairs of filaments of plastic material in such a manner that the filaments in each pair are spaced from each other in a first direction and the pairs of filaments are spaced from each other a given distance in a second direction, revolving the filaments of each pair at the moment of their extrusion and before being solidified about an axis extending between the filaments of each pair so as to twist the filaments of each pair together and to thus integrally connect the filaments, moving one of the filaments in each pair through the aforementioned given distance in the second direction while continuing extrusion of said filaments, repeating the last two steps to continuously form a net, and continuously drawing the net substantially in the direction in which said filaments are extruded.

The apparatus for carrying out the above method according to the present invention mainly comprises extrusion means for extruding a plurality of filaments of plastic material in substantially liquid state, wherein the extrusion means comprise two sets of nozzle members each formed

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with a bore for extruding a filament therethrough and wherein the nozzle members in each set are spaced from each other in a given distance and the nozzle members in the two sets are respectively arranged closely to each other to form pairs of adjacent nozzle members, revolving means for revolving each pair of nozzle members about an axis located between the bores thereof so that the filaments extruded through the bores of each pair of nozzle members are twisted together at the moment of their extrusion to thus be integrally connected to each other, shifting means for shifting the nozzle members of one set through the aforementioned given distance so that each nozzle member of the one set is again closely arranged to a respective nozzle member of the other set to form a pair of adjacent nozzle members ready to be revolved about an axis located between the bores thereof, and means for alternately operating said revolving means and said shifting means.

The novel features which are considered as characteristic for the invention are set forth in particular in the appended claims. The invention itself, however, both as to its construction and its method of operation, together with additional objects and advantages thereof, will be best understood from the following description of specific embodiments when read in connection with the accompanying drawings, in which:

FIG. 1 is a partial sectional front view through the apparatus according to the present invention, the section being taken along line 1-1' of FIG. 2;

FIG. 2 is a partial sectional side view, the section being taken along the line 2-2' of FIG. 1; and

FIG. 3 is a partially sectioned top view of the apparatus, the section being taken along line 3-3' of FIG. 1.

Referring now to the drawings, it will be seen that the apparatus according to the present invention comprises extrusion means which may include an elongated chamber 4 defining a bottom wall 8 and a top wall 6 in form of a separate cover connected by screws 7 and 7' to horizontal flanges extending laterally outwardly from the side walls of the chamber 4. Appropriate packings may be located between the bottom surface of the cover 6 and the top surface of the aforementioned flanges so that the cover 6 fluid-tightly closes the chamber 4. Conduit means 5 and 5' communicate with the interior of the chamber 4 and plastic material in liquid state and under pressure may be fed by means of pumps, not shown in the drawing, through the conduit means 5 and 5' into the interior of the chamber.

The extrusion means includes further two sets of nozzle members, that is the set of nozzle members 12, 12', 12'' and so on and the set of nozzle members 13, 13', 13'' and so on. The nozzle members in each set are spaced from each other a given distance and the nozzle members in the two sets are respectively arranged closely to each other to form pairs of adjacent nozzle members. Preferably each nozzle member is in the form of a semi-cylindrical body having a semi-cylindrical and plane vertical outer surface portion and the pairs of nozzle members being arranged with respect to each other so that the plane vertical surface portions thereof abut against each other and the semi-cylindrical surface portions thereof form together a cylindrical surface as can be clearly ascertain from FIG. 3. Thus for instance the semi-cylindrical bodies 12 and 13, in the position as shown in FIG. 3, form halves of a longitudinal divided cylinder, and the other semi-cylindrical bodies 12', 13'; 12'', 13'' and so on are arranged in the same manner. Each of the semi-cylindrical bodies forming the respective nozzle member is formed with a straight bore extending longitudinal therethrough and the bores for the nozzle members 12, 12', 12'' are respectively designated with 9, 9' and 9'', whereas the bores through the nozzle members 13, 13',

13" are respectively designated with 10, 10' and 10", as can be clearly ascertained from FIG. 3.

The semi-cylindrical nozzles 12, 12' and 12" and so on forming the first mentioned set of nozzle members are respectively located in semi-cylindrical openings formed in the bottom wall 8 of the chamber 4. The bottom 8 is further formed with a longitudinally extending slot in which a bar 18 of square or rectangular cross-section is tightly and slidably fitted and this bar extends with opposite ends thereof fluid-tightly sealed through the end walls of the chamber 4. The vertical edges of the semi-cylindrical openings in which the semi-cylindrical bodies 12, 12', 12" are respectively housed are located in the arrangement shown in FIG. 3 along one side face of the aforementioned slot and the bar 18 is likewise formed with a plurality of semi-cylindrical openings therethrough extending into the bar from one side face thereof engaging the aforementioned side face of the slot and the openings in the bar are likewise spaced the aforementioned given distance from each other, and the semi-cylindrical bodies 13, 13', 13" and so on which form the second set of nozzle members are respectively located in the aforementioned openings in the bar.

The apparatus according to the present invention includes further revolving means for revolving each pair of semi-cylindrical bodies, abutting against each other in the manner above described, about an axis coinciding with the axis of the common cylindrical surface of the paired nozzle members. Each of the semi-cylindrical nozzle members has a radial flange engaging with the bottom surface thereof the top surface of the bottom wall 8 of the chamber 4 or the top surface of the bar 18 providing thereby an improved seal preventing leakage of liquid plastic material under pressure along the outer surface of the respective nozzle member. The radial flanges of the nozzle members 12, 12', 12" and so on are extended in upward direction and have, respectively, in the upper portion of the chamber 4 a cylindrical portion 11 formed with a central bore therethrough through which a shaft 14 extends fixedly connected thereto in such a manner that the axis of the shaft coincides with the axis of rotation of the respective pair of nozzle members. Each of the shafts 14 projects in a fluid-tight manner with a portion thereof through a corresponding cylindrical opening in the cover 6 and a pinion 15 is fixedly connected to the portion of each shaft projecting beyond the cover 6. A pair of longitudinally extending racks 16 and 16' respectively mesh with all the pinions 15 and the racks 16 and 16' are provided on the outer surfaces thereof likewise with teeth which respectively mesh with a pair of gears 17 and 17' so that by revolution of the gears 17 and 17' in the same direction, the racks 16 and 16' will be shifted longitudinally and in opposite directions to thereby revolve the pinions 15, the shafts 14, connected thereto and therewith the aligned pairs of nozzle members about the aforementioned axes of revolution thereof. The cover 6 may be provided, as shown in FIG. 2, with a pair of parallel upwardly extending ribs to provide proper guiding for the racks 16 and 16'.

The apparatus of the present invention includes further shifting means for shifting the nozzle members 13, 13', 13" and so on the direction in which these nozzle members are spaced from each other and through the given distance at which these members are spaced from each other so that during shifting of the aforementioned nozzle members toward the left, as viewed in FIG. 3, the nozzle member 13' will be paired and be aligned with the nozzle member 12, the nozzle member 13" will be paired with the nozzle member 12', and so on. These shifting means include the aforementioned bar 18 and the means for shifting the bar include bar include a pin 19 projecting transversely to the elongation of the bar from the region of one end thereof and carrying a roller 20 engaged in a groove of an eccentric cam 21 which is rotated by means of a shaft 22.

The above-described apparatus will be operated as follows:

Plastic material in liquid state and under pressure is fed by pumps, not shown in the drawing, through the inlet conduits 5, 5' into the interior of the chamber 4 so that the plastic material will be extruded in form of filaments through the various bores of the nozzle members. The pairs of nozzle members are then revolved through one or more revolutions about their common axes by the revolving means above described while the filaments, respectively the net produced, are continuously withdrawn, for instance by being wound on a roll so that the filaments extruded through the bores of each pair of nozzle members are twisted together at the moment of their extrusion while they are still in substantially liquid state so that the pairs of filaments are integrally connected to each other. Subsequently thereto the set of nozzle members 13, 13', 13" and so on is shifted by the aforementioned shifting means, towards the left through a distance equal to the spacing between the aforementioned nozzle members so that these nozzle members, with the exception of the nozzle members 13, become respectively aligned with the nozzle members of the other set in the manner as described above while the extrusion of the plastic material through the bores of all of the nozzle members is continued and the paired nozzle members are then again revolved about their common axes by the revolving means in the manner as described before. Evidently, the nozzle member 13 will not be revolved since this nozzle member is not paired with a corresponding nozzle member of the first set. The bar 18 preferably carries adjacent its right end thereof, as viewed in FIG. 3, in a semi-cylindrical opening an additional semi-cylindrical nozzle member which during shifting of the bar 18 towards the left, as viewed in FIG. 3, is paired with the corresponding nozzle member of the first set of nozzle members which is mounted in the opening of the bottom wall 8. The nozzle members which are located in the openings in the bar 18 adjacent to the opposite ends thereof which are respectively not revolved when the bar 18 is in the one or in the other of the shifted end positions thereof and the bores through these nozzle members may therefore be used for forming the edges of the net. The diameter of the bores through these nozzle members is preferably made slightly larger than the diameter of the other bores so that the net may have reinforced edges. After each shifting of the bar 18 toward the right or toward the left the paired nozzle members are again revolved about their common axes so that the filaments extruded through the bores of the respective pair of nozzle members are twisted together in the manner above described.

The motion of the driving gears 17 and 17' moving the racks 16, 16' and the motion of the grooved cam 21 moving the shifting member or bar 18 must be strictly controlled so as not to overlap. The manner in which this alternate movement of the revolving means and the shifting means is accomplished does not form part of the present invention, but various means will be obvious to anybody working in this field. For instance it is possible to use an electric control with automatic switches opening and closing the circuits of electric drive motors connected to the shaft 22 of the cam and the gears 17, 17' respectively. If mechanical means are desired, an intermittent motion mechanism such as a Geneva gear may be used in known manner for the same purpose.

The alternating revolving and shifting of the nozzle members in the manner as above described will produce a net of odd meshes, having a form similar to the letter K, but such odd meshes will soon be changed to regular diamond-shaped meshes during pulling on the produced net in longitudinal direction and such pull may be provided by a driven roll on which the net may be wound.

It is obvious that the cross-section of the extruded filament may be chosen in any manner by a corresponding

cross-section of the respective bore through each nozzle member and the net may be formed with filaments of circular cross-section by providing the nozzle members with cylindrical bores. Furthermore, by twisting the filaments together in the aforementioned manner right at the moment after the extrusion a perfect interconnection between the filaments which will form strong joints of the net will be produced.

It will be understood that each of the elements described above, or two or more together, may also find a useful application in other types of apparatus for forming nets from extruded filaments of plastic material differing from the types described above.

While the invention has been illustrated and described as embodied in an apparatus for forming nets from extruded filaments of plastic material, it is not intended to be limited to the details shown, since various modifications and structural changes may be made without departing in any way from the spirit of the present invention.

For instance, while in the apparatus above described and as illustrated in FIGS. 1-3, the two sets of nozzle members are respectively arranged in straight rows, it is also possible to arrange the two sets of nozzle members along two concentric circles and in such an arrangement the racks and the shifting member are in the form of endless rings which are turned about a common axis coinciding with the axis of the aforementioned concentric circles.

Without further analysis, the foregoing will so fully reveal the gist of the present invention that others can by applying current knowledge readily adapt it for various applications without omitting features that, from the standpoint of prior art, fairly constitute essential characteristics of the generic or specific aspects of this invention and, therefore, such adaptations should and are intended to be comprehended within the meaning and range of equivalence of the following claims.

What is claimed as new and desired to be secured by Letters Patent is:

1. A method of manufacturing a net from plastic material comprising the steps of extruding a plurality of pairs of filaments of plastic material, the filaments in each pair being spaced from each other in a first direction and said pairs of filaments being spaced a given distance in a second direction; revolving the filaments of each pair at the moment of their extrusion and before being solidified about an axis extending between the filaments of each pair so as to twist the filaments of each pair together and to thus integrally connect each pair of filaments; moving one of the filaments in each pair through said given distance in said second direction while continuing extrusion of said filaments; repeating the last two steps to continuously form a net; and continuously drawing the net substantially in the direction in which said filaments are extruded.

2. A method as set forth in claim 1, wherein said filaments in each pair are spaced from each other in the first direction a distance considerably smaller than said given distance.

3. A method as set forth in claim 2, wherein said axis is located midway between the filaments of each pair of filaments.

4. An apparatus for continuously manufacturing a net from plastic material comprising, in combination, extrusion means for extruding a plurality of filaments of plastic material in substantially liquid state, said extrusion means comprising two sets of nozzle members each formed with a bore for extruding a filament therethrough, said nozzle members in each set being spaced from each other a given distance and said nozzle members in said two sets being respectively arranged closely to each other to form pairs of adjacent nozzle members; revolving means for revolving each pair of nozzle members about an axis located between the bores thereof so that the filaments extruded through the bores of each pair of nozzle mem-

bers are twisted together at the moment of their extrusion to thus be integrally connected to each other; shifting means for shifting the nozzle members of one set through said given distance so that each nozzle member of said one set is again closely arranged to a respective nozzle member of the other set to form a pair of adjacent nozzle members ready to be revolved about an axis located between the bores thereof; means for alternately operating said revolving means and said shifting means; and means for continuously drawing the interconnected filaments substantially in the direction of their extrusion.

5. An apparatus as set forth in claim 4, wherein said nozzle members and said bores therethrough are arranged in substantially vertical direction and said filaments are extruded in vertical downward direction.

6. An apparatus as set forth in claim 5, wherein said nozzle members in each set are arranged in a straight row and wherein said shifting means shifts said nozzle members of said one set in direction of said row.

7. An apparatus as set forth in claim 5, wherein each of said nozzle members is in the form of a semi-cylindrical body having a semi-cylindrical and a plane vertical outer surface portion, the pairs of nozzle members being arranged with said plane vertical surface portions thereof abutting against each other and said semi-cylindrical surface portions forming together a common cylindrical surface, said revolving means revolving each pair of nozzle members about an axis coinciding with the axis of said common cylindrical surface.

8. An apparatus as set forth in claim 7, wherein said nozzle members in each set are arranged in a straight row and wherein said shifting means shift said nozzle members of said one set in direction of said row, and wherein said extrusion means include further fluid-tight chamber means having a bottom wall and a top wall, wherein said bottom wall is formed with a first plurality of semi-cylindrical openings therethrough spaced a given distance from each other through which said semi-cylindrical bodies forming one set of said nozzle members respectively extend, said semi-cylindrical openings having vertical edges, said bottom wall being further formed with an elongated slot having one side face at which said vertical edges are located, and said shifting means including a bar arranged in said slot and being formed with a second plurality of semi-cylindrical openings therethrough spaced said given distance from each other through which the semi-cylindrical bodies forming the other set of said nozzle members respectively extend, and means for feeding plastic material in liquid form and under pressure into said chamber means.

9. An apparatus as set forth in claim 8, wherein said revolving means include shaft means for each semi-cylindrical body of said one set of nozzle members extending along the respective axes through and beyond said top wall of said chamber means and being fixedly connected to the respective semi-cylindrical body, a pinion fixed to the portion of each shaft means extending beyond said top wall, and said means for operating said revolving means including at least one rack meshing with said pinions, and gear means meshing with said rack for shifting the latter in longitudinal direction.

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