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TUBING AND PROCESS AND APPARATUS FOR PRODUCING THE SAME

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Fig. 1.

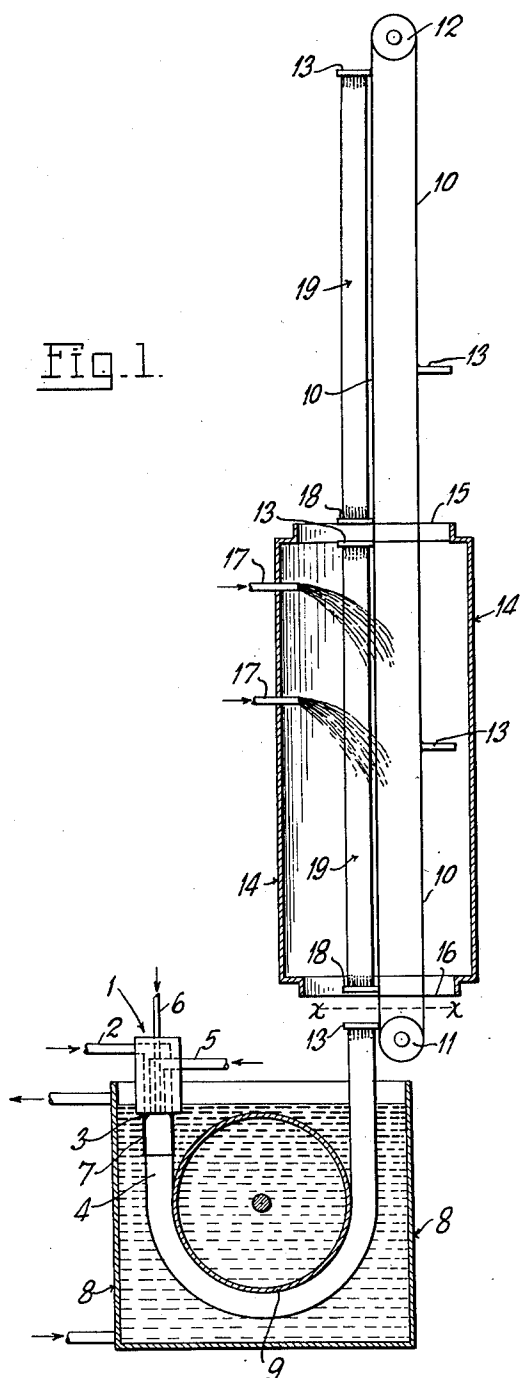


Fig. 2.

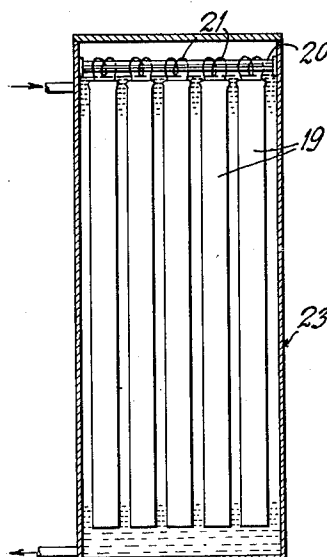
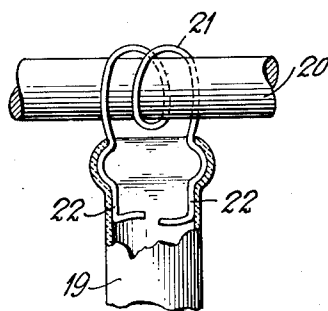


Fig. 3.



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TUBING AND PROCESS AND APPARATUS
FOR PRODUCING THE SAME

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Application September 1, 1934, Serial No. 742,478

16 Claims. (Cl. 18—57)

The invention relates in general to seamless, flexible tubing and, in particular, to artificial sausage casings characterized by having substantially uniform tensile strength and increased resistance to bursting, and to correlated improvements in the process and apparatus for preparing the same.

Heretofore, seamless, flexible tubing has been manufactured in a continuous manner by extruding a solution of viscose or the like through an annular orifice into a precipitating bath where it is coagulated and conveying the resulting tubing over rollers through the several purifying and conditioning baths and finally drying the tubing under tension. As a result of the fact that the soft, plastic tubing is passed over the rollers in a flattened condition, it displays two definite longitudinal creases which are less resistant than the remainder of the casing to transverse tension.

The solutions hitherto employed in the manufacture of seamless, flexible tubing have been of the concentration and viscosity such as are commonly used for the manufacture of filaments and films. In certain cases, it has been proposed to use viscose solutions of a viscosity of from 5,000 to 8,000 poises which is somewhat in excess of the usual viscosity. However, the tubing manufactured from any of these known solutions always shows a substantial orientation of the cellulose micellae in the direction of the flow of the material. This orientation is brought about by an alignment of the micellae as the solution passes through the narrow extrusion orifice. After extrusion, this orientation is further promoted by the fact that the freshly formed and relatively plastic tube is necessarily subjected to a longitudinal stretching for the purpose of moving it through the apparatus and to decrease the wall thickness.

Moreover, when the tubing is dried on prior apparatus comprising a plurality of spaced parallel rollers, the tubing shrinks so that it is subjected to a substantial longitudinal stretching and this renders the longitudinal creases sharper and, further, increases the orientation of the micellae longitudinally of the tubing.

The orientation of the micellae results in a difference in the longitudinal and transverse tensile strength and a noticeable difference in the lengthwise and transverse dilation and resistance to bursting, namely, that the resistance to transverse tension is considerably less than the resistance to longitudinal tension. When sausage casings are stuffed, however, the tension exerted

thereon transverse of the tube is at least as great, if not greater, than the longitudinal tension, for which reason it is desirable that the walls of the casing be strengthened accordingly. In consequence of the orientation of the micellae and the presence of the longitudinal creases, the tubing ruptures easily and shows a tendency to split along such creases when such casings are stuffed and linked. Likewise, during cooking, the prior casings show a substantial tendency to burst, as a result of which the meat stuffing extrudes and the sausage curls into an unsightly shape.

Accordingly, it is a general object of the invention to provide an improved seamless, flexible tubing substantially free from the above mentioned disadvantages and having a high resistance to transverse tension, as well as longitudinal tension, and a process for producing the same.

It is another object of the invention to provide an improved artificial sausage casing which is substantially free of definite longitudinal creases and which shows a substantial resistance to bursting, and a process for producing the same.

It is a specific object of the invention to provide a process and apparatus for producing artificial sausage casings from viscose and the like in a simple and economical manner without subjecting the tubing to a substantial longitudinal tension, and in which the tubing may be subjected both interiorly and exteriorly to purifying and conditioning treatments without forming definite longitudinal creases therein.

Other objects of the invention will in part be obvious and will in part appear hereinafter.

The invention accordingly comprises the several steps and the relation of one or more of such steps with respect to each of the others; the product possessing the features, properties and the relation of elements and the apparatus having the features of construction, combination of elements and arrangements of parts; which are exemplified in the following detailed disclosure, and the scope of the application of which will be indicated in the claims.

For a more complete understanding of the nature and the objects of the invention, reference should be had to the attached drawing, in which:

Fig. 1 is a side view, partly in section, of one embodiment of the novel apparatus of the invention for carrying out the steps of extrusion and coagulation of seamless, flexible tubing in accordance with the process of the invention.

Fig. 2 is a side view, partly in section, of a suitable apparatus for carrying out the steps of purification and conditioning the tubing in accordance with the process of the invention.

Fig. 3 is a detailed view, partly in section, of the means employed for suspending the tubing in the apparatus of Fig. 2.

In the practice of the invention, the process comprises extruding a suitable solution of a tube-forming material, preferably a cellulose solution of high viscosity, through an annular orifice in the form of a seamless tubing, and coagulating the tubing in a suitable bath. The tubing being coagulated, immediately upon extrusion, is subjected to a transverse tension, preferably by inflating the tubing with air and/or an internal coagulating liquid which stretches the tubing and decreases the thickness of the wall. The inflated tubing is passed through the coagulating bath at a rate not substantially greater than the rate of extrusion so that it is not subjected to a substantial longitudinal stretching. The inflated tubing is then severed into suitable sections and the sections maintained in an inflated or distended condition while being subjected, preferably both interiorly and exteriorly to purifying and conditioning treatments. The tubing is dried preferably in a manner such as to allow it to shrink freely without being subjected to a substantial longitudinal stretching and to prevent the formation of definite longitudinal creases therein which tend to weaken the walls of the tubing. For example, the tubing may be dried in a distended or inflated condition or by connecting the sections end to end and passing them through a drying atmosphere over rollers while rotating the longitudinal axis of the tubing.

One embodiment of the novel tube-forming apparatus of the invention is shown diagrammatically in Fig. 1 in which there is provided an extrusion nozzle 1 having a conduit 2 through which the tube-forming solution is introduced and an annular orifice 3 through which the solution is extruded in the form of a seamless, flexible tubing 4, a conduit 5 for supplying coagulating liquid to the interior of the tubing and a centrally disposed conduit 6 through which air may be supplied to the interior of the extruded tubing to stretch it transversely and to decrease the wall thickness. The diameter of the tubing may be limited by surrounding the tubing with a rigid hollow tube 7 of suitable diameter, disposed coaxial with and below the annular orifice. The tube 7 provides a means for supporting the soft plastic material and for limiting and controlling the expansion of the tubing. The lower end of the extrusion head 1 is disposed preferably so as to dip into a coagulating bath contained in a suitable vessel 8. The inflated tubing is passed through the bath around a rotatable roller 9 which is driven at a rate not substantially greater than the rate of extrusion so that the tubing is not subjected to a substantial longitudinal stretching.

In combination with the extrusion nozzle and bath, there is employed a conveying apparatus, preferably disposed vertically over the coagulating bath, comprising an endless chain 10 supported upon suitable spaced rollers 11 and 12 carrying a plurality of clamps 13 spaced equidistant from each other. The clamps 13 and the rollers 11 and 12 are constructed in a known manner so that the clamps 13 are automatically closed when they contact the roller 11 and are opened when they contact the roller 12. A part

of the conveying apparatus is enclosed in a chamber 14 having in the top and bottom thereof suitable openings 15 and 16 through which the conveyor passes and spray nozzles 17 disposed so as to subject the tubing to the action of treating liquids.

The coagulated tubing issuing from the bath 7 is gripped by one of the clamps 13 as the clamp is closed in passing around the roller 11. The tubing is withdrawn until a second clamp 13 has passed around the roller 11 and has closed onto the tubing. A pinch clamp 18 is now applied to the tubing at a point just above the lowermost clamp 13 and the tubing is then severed, as indicated by the broken line $x-x$, between the lower clamp 13 and the clamp 18. As each of the clamps 13 of the conveying chain 10 ascends, there hangs from it a section of tubing 19 having a clamp 18 closing its lower end. By reason of the air entrapped between clamps 13 and 18, the section of tubing is maintained in an inflated condition. In the chamber 14, the sections of tubing may be submitted by means of the spray nozzles 17 to the action of a suitable liquid for purifying or regenerating the tube-forming material.

The sections of tubing 19 as they come out of the chamber 14 are released by the clamp 13 as it passes over the roller 12. The tubing is then removed from the conveyor and the clamp 18 taken off the lower end. The sections then are hung up, a considerable number at a time, on a common hanger 20, as shown in Fig. 2, by means of clips 21. As shown in Fig. 3, the clip 21 is in the form of a coil spring which surrounds the hanger 20, the ends 22 of the clip serving to distend the top of the tubing and to preserve its hollow form.

The sections of tubing hung on the hanger 20 are suspended in a suitable chamber 23 wherein the tubing may be treated in sequence with various liquids for the purpose of purifying and conditioning the tubing. By reason of the fact that the sections of tubing are maintained in a distended condition and are open at both the top and bottom, the tubing may be subjected to the action of the liquids both interiorly and exteriorly which greatly decreases the time required for obtaining the desired object of the treatment.

It is obvious that the extrusion nozzle 1 may be positioned so as to extrude the tubing in a horizontal or an upward direction instead of in a downward direction, and that a plurality of extrusion nozzles may be employed with a single movable conveyor which is adapted simultaneously to remove the product of the several nozzles.

For drying the tubing, there may be employed any suitable apparatus in which the tubing is not subjected to longitudinal stretching or to passage over rollers in a manner such as to form longitudinal creases therein. Thus, for example, the tubing may be dried while in an inflated or distended condition and/or while rotating the axis of the tubing in its passage over supporting rollers.

In the now preferred practice, the sections of tubing are removed from the spring clips 21 and united end to end by suitable clamps so as to form an endless tubing which is passed through a drying apparatus such, for example, as that shown in the co-pending application, Serial No. 743,589 filed September 11, 1934. This apparatus comprises a heating chamber having spaced rotatable rollers mounted therein and about which the tubing is adapted to be advanced. The rollers

are adapted to define a path which becomes progressively shorter as the tubing is advanced about the rollers which enables the tubing to shrink longitudinally during the drying without being subjected to longitudinal stretching. By preventing longitudinal stretching of the tubing, the production of definite longitudinal creases in the tubing is avoided, and the orientation of the micellae is substantially lessened.

The tube-forming solution employed in the process of the invention may comprise any suitable film-forming solutions of non-fibrous plastic material such as viscose solutions or solutions of cellulose esters, such, for example, as cellulose nitrate; cellulose ethers, such, for example, as methyl cellulose; cellulose oxy-ethers, such, for example, as eth-oxy cellulose; or solutions of synthetic resins and other plastic, non-fibrous materials such, for example, as polymerized vinyl resins, gelatin, casein and the like.

In the preparation of tubing having superior bursting strength and high elasticity in both transverse and longitudinal directions, it has been found advantageous to employ solutions of non-fibrous cellulosic materials which are characterized by having a relatively high viscosity and concentration. Such solutions are prepared preferably from cellulose or cellulose derivatives which show a minimum of degradation of the cellulose molecule. Thus it has been found preferable to use a solution having a viscosity of from about 20,000 to 100,000 poises and preferably from about 30,000 to 50,000 poises and a concentration of from about 12% to 25% and preferably from about 15% to 20% by weight of solid material. In the higher range of viscosity and concentration, such solutions have the consistency of paste.

By way of illustrating the process, but not by way of limiting the scope of the invention, the following examples are given:

Example 1.—To prepare an artificial sausage casing having substantially improved tensile strength and elasticity transversely and longitudinally of the casing, 20 kg. of nitrocellulose having a nitrogen content of 11.9% are immersed and agitated in 80 kg. of a solvent consisting of, by weight, 60 parts of alcohol and 20 parts of ether until a substantially homogeneous mass is obtained. The conditions of the manufacture of the nitrocellulose should be such that the solution thus produced has a viscosity of, for example, about 50,000 poises. Employing the apparatus of Fig. 1, this solution is extruded through the annular nozzle 1 directly into a bath which may consist of, for example, 75% of water, 20% of alcohol and 5% of ether, wherein the nitrocellulose is coagulated. Coagulating liquid comprising a similar solution is introduced interiorly of the tube. As the tube issues from the orifice, it is inflated with air to stretch it transversely and to expand it to the desired diameter. The rate at which the tubing is drawn around the roller 9 and through the bath is such that the tubing is not subjected to a substantial longitudinal stretching.

As the tubing is withdrawn from the bath, it is attached to the endless belt 10 by one of the clamps 13. A clamp 18 is then applied as above described and the tubing is then cut into sections. As the sections move through the chamber 14, they are sprayed with water or a suitable solution by means of the nozzles 17 to complete the precipitation of the nitrocellulose and to remove the residual solvents. The sections are then suspended in the treating chamber 23

where they are maintained in a distended condition by means of the spring clips 21 and are subjected successively, both interiorly and exteriorly, to the treatments of washing, denitrating and softening. If desired, the tubing may be denitrated to a desired nitrogen content with a suitable solution such, for example, as a bath consisting of 5% sodium hydrosulphide in water. The tubing may be softened with a suitable solution such, for example, as a 20% aqueous solution of glycerine.

The finished tubing is dried free of tension, preferably in an apparatus such as shown in the co-pending application, Serial No. 743,589 filed September 11, 1934 so that the tubing may shrink without the formation of definite longitudinal creases therein and without increasing the longitudinal orientation of the micellae in the tubing.

Example 2.—For the preparation of artificial sausage casing from cellulose hydrate, there may be employed advantageously a viscose solution containing 15% by weight of cellulose and 12% by weight of sodium hydroxide, the aging of the solution being terminated when the maturation number is 3 and the viscosity is approximately 50,000 poises. This solution may be formed into casings following the process steps of Example 1 and employing the apparatus disclosed in the drawing, the coagulation, regeneration, desulphurization, washing and conditioning with glycerine or the like being carried out with the use of suitable solutions known to those skilled in the art, it being understood that the tubing is maintained in an inflated or distended condition throughout such treating steps and that the tubing is dried as described in Example 1.

It has been found by test that prior casings prepared from solutions of viscose of the usual viscosity and concentration have a longitudinal tensile strength of 2.0 kg./sq. mm. and a transverse tensile strength of only 1.6 kg./sq. mm., while the casings prepared in accordance with the process of the present invention and using viscose solutions of high viscosity and high concentration show a value of 2.3 kg./sq. mm. for both the longitudinal and transverse directions respectively when tested under identical conditions. Thus it is found that the tubing prepared from cellulose or cellulose derivative solutions having high viscosity and concentration are characterized by a transverse tensile strength at least as great as the longitudinal tensile strength, the transverse strength being substantially greater than that of similar tubing made under the prior practice. The increased transverse strength and elasticity materially improve the resistance to bursting which is an advantage when the tubing is employed as sausage casing and shirred, stuffed, linked and cooked.

One of the advantages of employing solutions of high viscosity, in accordance with the preferred practice of the invention, is that one is able to employ cellulose or cellulose derivatives having a minimum of decomposition of the molecules. This is of great importance for, as is well known, the strength of the resulting product is greater in inverse proportion to the decomposition of the cellulose unit. With solutions having a very high content of solid matter, there is the added advantage that only a relatively small amount of solvent is required which is economical especially where the solvent comprises organic materials such as is the case with the cellulose derivatives. Furthermore, these highly viscous

and highly concentrated solutions coagulate substantially faster than solutions of low viscosity having a relatively low solid content, in consequence of which the freshly extruded products acquire a certain physical stability immediately after leaving the extrusion orifice. This makes the extrusion process simple and easy of operation and obviates the use of a rigid internal support for the freshly formed tube.

Since certain changes in carrying out the above process and apparatus and certain modifications in the article which embodies the invention may be made without departing from its scope, it is intended that all matter contained in the above description shall be interpreted as illustrative and not in a limiting sense.

It is also to be understood that the following claims are intended to cover all of the generic and specific features of the invention herein described, and all statements of the scope of the invention which, as a matter of language, might be said to fall therebetween. In the claims, the term "solution" as used with reference to the tube-forming material is intended to include both true solutions thereof as well as colloidal solutions or mixtures in which the material is substantially uniformly dispersed.

Having described our invention, what we claim as new and desire to secure by Letters Patent is:

1. In a process for the preparation of seamless, flexible tubing, the steps comprising extruding a suitable solution of non-fibrous plastic material through an annular nozzle in the form of a tube, coagulating the tubing while subjecting the freshly extruded tubing to a positively induced transverse stretching without subjecting the tubing to a substantial longitudinal stretching and maintaining the tubing in a distended condition while subjecting the tubing to purifying and conditioning treatments.

2. In a process for the preparation of seamless, flexible tubing, the steps comprising extruding a suitable solution of viscose or the like through an annular nozzle in the form of a tube, coagulating the tubing while subjecting the freshly extruded tubing to a positively induced transverse stretching without subjecting the tubing to a substantial longitudinal stretching, severing the tubing into sections and maintaining the sections in a distended condition while subjecting the sections to purifying and conditioning treatments.

3. In a process for the preparation of seamless, flexible tubing, the steps comprising extruding a suitable solution of non-fibrous cellulosic material through an annular nozzle in the form of a tube, coagulating the tubing while inflating the tubing with a gas to produce transverse stretching and to decrease the thickness of the wall, passing the inflated tubing through the coagulating bath without subjecting it to longitudinal stretching, severing the tubing into sections and maintaining the sections in a distended condition while subjecting the tubing to purifying and conditioning treatments.

4. In a process for the preparation of seamless, flexible tubing, the steps comprising extruding a suitable solution of viscose or the like through an annular nozzle in the form of a tube, coagulating the tubing while inflating the tubing with a gas to produce transverse stretching and to decrease the thickness of the wall, passing the inflated tubing through the coagulating bath without subjecting it to longitudinal stretching, severing the tubing into sections and maintaining the sections in a distended condition while

subjecting the tubing interiorly and exteriorly to purifying and conditioning treatments.

5. In a process for the preparation of seamless, flexible tubing, the steps comprising extruding a solution of cellulose having a viscosity of from 20,000 to 100,000 poises and a concentration of from about 12% to 25% by weight of solid material through an annular nozzle in the form of a tube, coagulating the tube while subjecting the freshly extruded tube to positively induced transverse stretching without subjecting the tube to a longitudinal stretching, severing the tube into sections, maintaining the sections in a distended condition while subjecting the sections to purifying and conditioning treatments, and drying the tubing free of such tension as will cause a substantial longitudinal stretching thereof.

6. In a process for preparing seamless, flexible tubing from solutions of cellulose, the steps comprising preparing a solution of a suitable cellulose material having a viscosity of from 20,000 to 100,000 poises and a concentration of from about 12% to 25% by weight of solid material, extruding said solution through an annular orifice in the form of a tube, coagulating the cellulose material while subjecting the tube to a positively induced transverse stretching without subjecting the tube to a longitudinal stretching, and maintaining the tubing in a distended condition while subjecting the tubing to purifying and conditioning treatments.

7. In a process for preparing seamless, flexible tubing from solutions of cellulose, the steps comprising preparing a solution of a suitable cellulose material having a viscosity of from 20,000 to 100,000 poises and a concentration of from about 12% to 25% by weight of solid material, extruding said solution through an annular orifice in the form of a tube, coagulating the cellulose material while subjecting the tube to a transverse stretching by inflating it with air, passing the inflated tubing through the coagulating bath without subjecting the tube to a longitudinal stretching, and maintaining the tubing in a distended condition while subjecting the tubing to purifying and conditioning treatments.

8. In a process for preparing seamless, flexible tubing from solutions of cellulose, the steps comprising preparing a viscose solution having a viscosity of from 30,000 to 50,000 poises and a concentration of from about 15% to 20% by weight of solid material, extruding said solution through an annular orifice in the form of a tube, coagulating the viscose while subjecting the tube to a transverse stretching by inflating it with air, and maintaining the tubing in a distended condition while subjecting the tubing to purifying and conditioning treatments without subjecting the tubing to a substantial longitudinal stretching.

9. In a process for preparing seamless, flexible tubing from solutions of cellulose, the steps comprising preparing a solution of nitrocellulose having a viscosity of from 30,000 to 50,000 poises and a concentration of from about 15% to 20% by weight of solid material, extruding said solution through an annular orifice in the form of a tube, coagulating the nitrocellulose while subjecting the tube to a transverse stretching by inflating it with air, and maintaining the tubing in a distended condition while subjecting the tubing to purifying and conditioning treatments without subjecting the tubing to a substantial longitudinal stretching.

10. In an apparatus for preparing seamless, flexible tubing free of longitudinal creases, the

combination of an annular nozzle, means for supplying a tube-forming material to said nozzle, means for supplying coagulating liquid both interiorly and exteriorly of the tubing extruded from said nozzle, means for supplying a gas interiorly of the extruded tubing for inflating the tubing, means for conveying the inflated tubing away from said nozzle, said conveying means comprising an endless conveyor having means spaced apart for gripping and collapsing the inflated tubing at predetermined points, means for dividing the inflated tubing into inflated sections and means for contacting the inflated sections with treating liquids.

11. In an apparatus for preparing seamless, flexible tubing free of longitudinal creases, the combination of an annular nozzle, means for supplying a tube-forming material to said nozzle, means for supplying coagulating liquid both interiorly and exteriorly of the tubing extruded from said nozzle, means for supplying a gas interiorly of the extruded tubing for inflating the tubing, means for conveying the inflated tubing away from said nozzle, said conveying means comprising an endless conveyor having means spaced apart for gripping and collapsing the inflated tubing at predetermined points whereby the tubing may be divided into inflated sections and means for subjecting the inflated tubing to treating liquids.

12. In an apparatus for preparing seamless, flexible tubing free of longitudinal creases, the combination of an annular nozzle, means for supplying a tube-forming material to said nozzle, means for supplying coagulating liquid both interiorly and exteriorly of the tubing extruded from said nozzle, means for supplying a gas interiorly of the extruded tubing for inflating the tubing, means for conveying the inflated tubing away from said nozzle, said conveying means comprising an endless, vertically disposed conveyor having means spaced apart for gripping and collapsing the inflated tubing at predetermined points whereby the tubing may be divided into inflated sections and a chamber enclosing a portion of said conveyor and means for subjecting the sections to treating liquids as the sections pass through said chamber.

13. In an apparatus for preparing seamless, flexible tubing free of longitudinal creases, the combination of means for extruding a suitable material in the form of a seamless tubing, means

for inflating the freshly extruded tubing, means to pass the inflated tubing through a bath of liquid without subjecting it to a substantial longitudinal stretching, an endless conveyor having means for gripping and closing the inflated tubing at spaced intervals permitting the inflated tubing to be divided into inflated and closed sections.

14. In an apparatus for preparing seamless, flexible tubing free of longitudinal creases, the combination of means for extruding a suitable material in the form of a seamless tubing, means for inflating the freshly extruded tubing, means for limiting the expansion of the inflated tubing, means to pass the inflated tubing through a bath of liquid without subjecting it to a substantial longitudinal stretching, an endless conveyor having means for gripping and closing the inflated tubing at spaced intervals and means for dividing the inflated tubing into inflated and closed sections.

15. In an apparatus for preparing seamless, flexible tubing free of longitudinal creases, the combination of an extrusion nozzle disposed to extrude a seamless tubing downwardly into a coagulating bath, means for inflating the freshly extruded tubing, means to pass the inflated tubing through the coagulating bath without subjecting it to a substantial longitudinal stretching, an endless conveyor disposed above said bath and having means for gripping disposed thereon at spaced intervals whereby the inflated tubing may be gripped and closed at predetermined points as it issues from the coagulating bath and means for dividing the inflated tubing into inflated and closed sections.

16. In an apparatus for preparing seamless, flexible tubing free of longitudinal creases, the combination of means for extruding a suitable material in the form of a seamless tubing, means for inflating the freshly extruded tubing, means to pass the inflated tubing through a bath of liquid without subjecting it to a substantial longitudinal stretching, means for conveying said tubing, and said conveying means being provided with means for gripping and closing the inflated tubing at spaced intervals permitting the inflated tubing to be divided into inflated and closed sections.

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