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R. WEINGAND ET AL

2,172,426

TUBING AND PROCESS OF PRODUCING THE SAME

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Fig. 1.

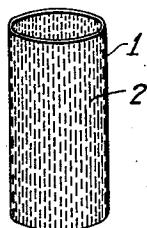


Fig. 2.

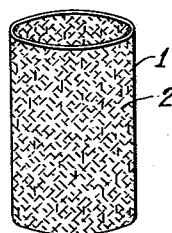


Fig. 3.

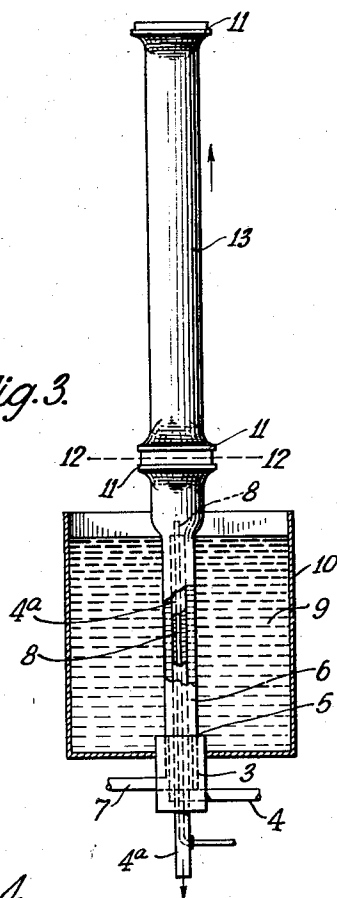


Fig. 4.

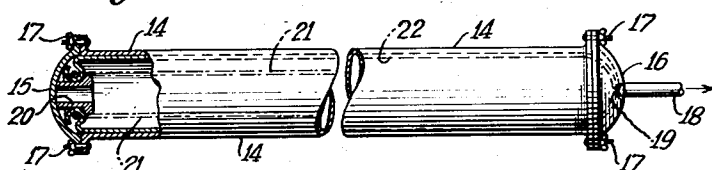
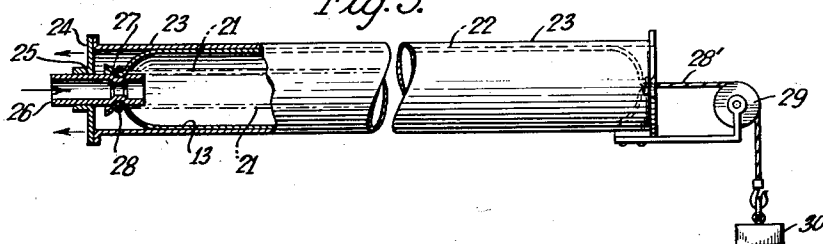


Fig. 5.



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TUBING AND PROCESS OF PRODUCING THE SAME

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Application December 20, 1935, Serial No. 55,380
In Germany December 7, 1934

18 Claims. (Cl. 18—57)

The invention relates in general to containers adapted for use as casings and, in particular, to an improved sausage casing having increased transverse tensile strength and resistance to bursting and includes correlated improvements in the process for preparing the same.

In the manufacture of casings from colloidal plastic materials it is essential to impart to the casing the greatest possible tensile strength transverse of the casing or tubing because when the casing is stuffed, it is subjected to high transverse pressure.

The casings heretofore produced by extruding a solution of viscose or the like through an annular orifice show a substantial orientation of the cellulose micellae in the direction of extrusion, that is, parallel to the longitudinal axis of the tubing. This orientation is brought about by an alignment of the micellae as the solution passes through the extrusion orifice. The longitudinal orientation is further increased when the tubing is subjected to further treatments and during drying.

Orientation of the micellae in a direction parallel to the longitudinal axis imparts a greater tensile strength in the lengthwise direction than in the transverse direction. In consequence of this variation in tensile strength, the casing ruptures relatively easily and shows a tendency to split during stuffing and during cooking.

It is a general object of the invention to provide improved hollow tubular bodies substantially free from the above mentioned disadvantages and having a high resistance to both longitudinal and transverse tension, and a process for producing the same.

It is another object of the invention to provide an improved seamless flexible tubing adapted for use as a sausage casing characterized by having such orientation of the micellar structure that the tensile strength transverse of the casing is as great, or greater, than the tensile strength lengthwise of the casing, and a process for producing the same.

A further object of the invention is to provide a process for producing seamless flexible tubing adapted to be used as a casing whereby there is imparted to the tubing such arrangement of the micellae that the tubing exhibits a substantially increased transverse tensile strength without materially decreasing the longitudinal tensile strength.

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

We have found that containers adapted for use

as a casing having an improved transverse tensile strength may be produced by forming a hollow tubular body from a colloidal plastic material having a micellar structure, modifying said structure so that the majority of the micellae thereof lie at an angle to the longitudinal axis of the hollow body, and rendering the modified structure substantially permanent. More particularly, the process consists in forming a seamless, flexible tubing from a colloidal plastic material capable of being hardened and enlarging the diameter of said tubing after the plastic material has been partially, but not completely, hardened, and thereafter completing the hardening of the material, preferably while the tubing is in the enlarged state.

For forming the tubing of the invention, there may be employed various colloidal plastic materials having a micellar structure, such as, for example, solutions of viscose cuprammonium cellulose, zinc chloride solutions of cellulose, cellulose derivatives such as cellulose esters, oxy ethers and ethers, gelatin, casein, polymerization products of vinyl esters, acrylic esters and similar colloidal plastic masses.

According to the plastic material used, partial hardening of the tubing formed therefrom may be effected by partial coagulation of the material by suitable known liquids or gases, by evaporation, or by extraction of the solvents used in dissolving the plastic material. In the latter case, the tubular body, in a gel condition, is expanded after the solvents have been partially removed from the material, for example, to the extent of 50% to 75%. Moreover, the fluid used for expanding the tubular body in accordance with certain embodiments of the process may or may not have simultaneously the effect of coagulating and hardening the plastic material.

The hollow tubular body may be formed by any known method such, for example, as extruding the solution through an annular nozzle to form a seamless tubing or by coating a suitable cylindrical mandrel with the solution and stripping the partially hardened skin from the mandrel.

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

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

Fig. 1 is a diagrammatic representation of a section of tubing illustrating the micellar condition before treatment by the process of the invention;

Fig. 2 represents a section of tubing after treatment showing a rearrangement of the micellae and illustrates one embodiment of the novel article of the invention;

Fig. 3 is a side elevation, partly in section, of an apparatus suitable for carrying out certain steps in one embodiment of the process;

Fig. 4 is a side view, partly in section, of another apparatus suitable for effecting a second embodiment of the process; and

Fig. 5 depicts a suitable apparatus in which a further embodiment of the process may be accomplished.

In the practice of the invention, a seamless, flexible tubing is formed by extruding through an annular orifice a suitable colloidal plastic material capable of hardening and having a micellar structure. This freshly extruded tubing is partially hardened as, for example, by passing the tubing through a coagulating bath. The partly hardened tubing, before expanding or stretching, comprises a thin walled tubular body 1 (Fig. 1) having a micellar structure in which the majority of the micellae 2 are aligned substantially parallel to the longitudinal axis of the tubing. In Fig. 1, the individual micellae 2 have been enlarged for the purpose of illustrating their relative positions in the wall of the tubing 1.

The partially hardened tubing is now modified by increasing the diameter thereof, preferably by stretching the tubing transversely as by expanding or inflating it with a fluid such, for example, as a gas or a liquid or, alternatively, by reducing the pressure on the outside of the tubing. The expansion of the tubing may be carried out in a continuous manner immediately following the step of partial hardening, or the partially hardened tubing may be cut into sections and the sections expanded inside a cylinder which serves to limit and control the diameter of the finished tubing. We find that the transverse tensile strength of the tubing is substantially increased if the original diameter is enlarged from 40% to 100% and preferably from 50% to 80%.

After expansion of the tubing, the colloidal plastic mass is completely hardened by a treatment which renders the micellar structure substantially permanent. For example, the stretched tubing, preferably while in the expanded condition, is treated with a liquid or gas capable of completely coagulating and hardening the plastic material. The tubing may then be purified, softened, dried, or otherwise processed as desired.

A section of the expanded tubing is shown in Fig. 2 from which it will be noted that the micellar structure has been modified so that the majority of the micellae 2 are aligned at an angle to the longitudinal axis of the tubular body 1. It is to be understood that the angle made by the micellae with respect to the longitudinal axis may be varied by varying the degree of expansion.

In Fig. 3 there is shown a suitable apparatus for carrying out one embodiment of the process in which there is provided an extrusion nozzle 3 having a conduit 7 through which the colloidal plastic material is introduced and an annular orifice 5 through which said material is extruded in the form of a seamless flexible tubing 6. The nozzle is also provided with a conduit 4 for supplying a coagulating liquid to the interior of the tubing and a conduit 8 for supplying air to the

exterior of the tubing. Further, a conduit 4a which extends upwardly into the coagulating bath and terminates just below the air conduit with which it is concentric, serves to conduct the coagulating liquid away from the interior of the formed tube. The nozzle is disposed so as to extrude the material directly into a coagulating bath 9 contained in a suitable vat 10. Conduit 8 is of such a length that it terminates slightly above the level of the liquid in the interior of the tubing and of the liquid in the vat. By means of this conduit, the partially hardened, relatively plastic tubing is inflated immediately as it passes from the bath until the diameter is enlarged to the desired dimension. The gas introduced through the conduit 8 preferably should have no hardening effect on the plastic material.

The distance which the tubing travels through the coagulating bath is adjusted so that the extruded tubing is partially, but not completely, hardened in the bath. The inflated tubing is withdrawn by any suitable conveying means such as that described in our copending application Serial No. 742,478. Suitable clamps 11 are applied to the inflated tubing at spaced intervals so as to close the ends of the tubing and entrap air therein. If desired, the clamps 11 may be applied to the tubing in pairs positioned close to each other and the tubing severed along a line 12 between the clamps thus forming an expanded section 13, as shown in Fig. 3. The inflated tubing, with or without being severed into sections, is then treated by known means with a suitable liquid or gas for completing the hardening of the plastic material and for purifying, softening, and otherwise finishing the tubing.

If desired, the tubing may be extruded partially hardened, cut into sections of suitable length and sections then expanded. For carrying out this embodiment of the process, there may be provided, as shown in Fig. 4, a cylinder 14 of non-porous rigid material for limiting the expansion, the cylinder having airtight closures 15 and 16 at each end, the closures being demountable and adapted to be affixed thereto by suitable thumb screws 17, the cylinder having an exhaust outlet 18 for evacuating the interior. If desired, one end of the tubing may be tied together as shown at 19 and the other end slipped over a knob 20 positioned on the inner surface of the closure 15. When the cylinder 14 is evacuated, the pressure differential will cause an expansion of the tubing which is limited by the diameter of the confining cylinder. The initial position of the unexpanded tubing is shown by the broken lines 21 while the broken lines 22 indicate the position of the tubing after expansion.

Alternatively, the tubing may be inflated within a confining member as shown in Fig. 5. For example, there may be provided a limiting cylinder 23 open at both ends into which the tubing is inserted. One end of the cylinder 23 is provided with a demountable end plate 24 having an orifice provided with a sleeve 25 through which is passed a tube 26 having an annular groove 27. One end of the tubing is slipped over the tube 26 and a cord 28 tied around the tubing at 27 as shown. The tubing 13 is inserted in the cylinder 23 and the open end of the tubing closed, as by tying it together with a cord 28'. A fluid such as air is now introduced into the interior of the tubing through the tube 26.

It is advisable to avoid excessive longitudinal shrinkage of the tubing during expansion to pre-

vent undue shortening and to preserve its longitudinal tensile strength. This may be accomplished by placing the tubing under tension during expansion as by slightly stretching the tubing longitudinally, preferably to an amount of from 10% to 20% of its original length to compensate for any shortening of the tubing caused by expansion. For example, to stretch the tubing longitudinally to compensate for any shrinkage, the cord 28 of the apparatus of Fig. 5 may be passed over a roller 29 and a suitable weight 30 attached to the end thereof. With the apparatus of Fig. 4 the pressure differential usually will be sufficient to prevent longitudinal shrinkage of the tubing.

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

Example I

A viscose solution, containing 9% cellulose and 8% alkali and having an ammonium chloride maturation value of 3, is extruded from an annular nozzle 40 mm. in diameter into a coagulating bath which contains 15% sodium sulphate and 10% sulphuric acid. The rate of extrusion is about 15 meters a minute and the distance traveled by the tubing in the coagulating bath is one meter. In this bath the viscose is partially coagulated but the cellulose is not regenerated. The partially coagulated tubing may be cut, immediately after leaving the coagulating bath, into 5 meter lengths and these sections are closed at one end by means of a suitable clamp inserted in a confining cylinder of the type shown in Fig. 5 and promptly thereafter carbon dioxide is blown into the section through the open end in an amount sufficient to enlarge the diameter to about 70 mm. The sections of tubing, while inflated, are treated as by spraying with a solution of sodium sulphate and sulphuric acid or by passing them through such a solution. This treatment results in the regeneration of the cellulose, and the sections of tubing are then washed, desulphurized, bleached, impregnated with glycerine and finally dried.

Example II

A 20% solution of nitrocellulose, having a nitrogen content of 11.9% is dissolved in a solvent comprising ether and alcohol in which the ratio of ether to alcohol is 1:3. The solution is extruded at the rate of 7 meters a minute from an annular nozzle 40 mm. in diameter into a coagulating bath consisting of a mixture of 25% alcohol and 75% water. The depth of the coagulating bath is so adjusted that the tubing is in the coagulating bath for 10 seconds. As the tube issues from the coagulating bath, air is blown into the interior thereof. The inflated tubing, which still contains around 50% of the original solvents, is then clamped together by pairs of pinch clamps positioned at suitable intervals, the sections being hermetically closed by the clamps so that the air inside the tubing cannot escape. The inflated sections are severed one from another and introduced, one section after another, into a cylinder of suitable length and diameter of the type shown in Fig. 4. After this cylinder has been closed at both ends a vacuum is created in it, whereby the walls of the tubing are caused to expand by the greater pressure inside the tubing until they contact fully the inner surface of the cylinder.

The section of tubing, which has been thus in-

creased in diameter is then washed with water to remove the rest of the solvents, denitrated, for example, with sodium hydrosulphide until the nitrogen content falls to from 0.5% to 2% by weight, again washed and finally dried. The denitrated cellulose tubing thus produced has a transverse tensile strength of about 4 kilograms to the square meter as compared with a transverse tensile strength of 2 kilograms for tubing not expanded and treated in accordance with the invention.

It will be observed that the process of the invention produces a rearrangement of the micellae when the micellar structure is in a deformable state, and thereafter the new arrangement of the micellae is rendered permanent. This result is not obtained if the tubing is inflated simultaneously with extrusion and before partial coagulation or hardening, because the micellar structure has not been established, in consequence of which the rearrangement is destroyed when the tubing is stretched during the coagulation and drying. Also, the novel result of the present invention is not obtained if the tubing is completely coagulated or hardened and then inflated later, for example during or after drying, because the micellar structure in the completely hardened tubing is no longer deformable.

By the process of the present invention it is possible to produce seamless flexible tubing adapted for use as a casing for enclosing various commodities as sausage, which has a transverse tensile strength from 1.5 to 2.5 times greater than a tubing not so treated. This product is further characterized by having thinner walls than casings heretofore produced and, therefore, an increased edibility. Expansion of the casing also reduces the swelling capacity of the casing so that there is less variation between the diameter of the dry and of the wet casing which facilitates stuffing operations. When casings are expanded within a limiting cylinder, it is possible to produce products which have a specified and uniform diameter.

Since certain changes in carrying out the above process, and certain modifications in the article which embody the invention may be made without departing from its scope, it is intended that all matter contained in the above description or shown in the accompanying drawing 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.

We claim:

1. A process for manufacturing containers adapted for use as casings, which comprises shaping a seamless flexible tubing from a colloidal plastic material, which is capable of being hardened, by extrusion, partially hardening said tubing, thereafter expanding the diameter of the tubing from 40-100% of its initial diameter, and completing the hardening of the material while in expanded condition.

2. A process for manufacturing containers adapted for use as casings, which comprises shaping a seamless flexible tubing from a colloidal plastic material, which is capable of being hardened, by extrusion to form a micellar structure, partially hardening said tubing, thereafter ex-

panding the diameter of the tubing and simultaneously restraining the tubing to substantially prevent longitudinal shrinkage, and completing the hardening of the material while in expanded condition.

5 3. A process for manufacturing containers adapted for use as casings, which comprises shaping a seamless flexible tubing from a colloidal plastic material, which is capable of being hardened, by extrusion, partially hardening said tubing, thereafter expanding the diameter of the tubing while stretching it slightly longitudinally substantially to prevent longitudinal shrinkage, and completing the hardening of the material while in expanded condition.

10 4. A process for manufacturing containers adapted for use as casings, which comprises extruding a solution of viscose through an annular orifice to form a seamless, flexible tubing, partially coagulating said viscose tubing without materially regenerating the cellulose contained in the viscose, thereafter enlarging the diameter of said tubing by expansion, and regenerating the cellulose in said tubing while the tubing is in an expanded condition.

20 5. An article of manufacture adapted for use as a casing comprising a hollow tubular body formed from a colloidal plastic material having a micellar structure, and having a majority of the micellae oriented at an angle to the longitudinal axis of said body.

30 6. An article of manufacture adapted for use as a casing comprising a hollow tubular body formed from a colloidal plastic material having a micellar structure, a majority of the micellae lying at an angle to the longitudinal axis of said body, and having a transverse tensile strength of from 1.5 to 2.5 times greater than that of a body formed from said material and in which the micellae lie substantially parallel to the longitudinal axis of the body.

40 7. An article of manufacture adapted for use as a casing comprising a seamless flexible tubing formed from a colloidal plastic material having a micellar structure, and having a majority of the micellae oriented at an angle to the longitudinal axis of said tubing.

50 8. An article of manufacture adapted for use as a casing comprising a seamless flexible tubing formed of a colloidal, non-fibrous cellulosic material having a micellar structure, and which has a majority of the micellae oriented at an angle to the longitudinal axis of the tubing.

55 9. An article of manufacture adapted for use as a casing comprising a seamless flexible tubing formed of regenerated cellulose having a micellar structure, and which has a majority of the micellae oriented at an angle to the longitudinal axis of the tubing.

60 10. An article of manufacture adapted for use as a casing comprising a seamless flexible tubing formed of partially denitrated nitrocellulose having a micellar structure, and which has a majority of the micellae oriented at an angle to the longitudinal axis of the tubing.

65 11. An article of manufacture adapted for use as a casing comprising a seamless flexible tubing formed of partially denitrated nitrocellulose having a micellar structure, a majority of the micellae oriented at an angle to the longitudinal axis of said tubing, and having a transverse tensile strength of from 1.5 to 2.5 times as great as that of a tubing formed from said nitrocellulose and in which the micellae lie substantially parallel to the longitudinal axis of the tubing.

12. An article of manufacture adapted for use as a casing and being in the form of a hollow tubular body formed of a material comprising a colloidal plastic substance having a micellar structure in which a number of the micellae are oriented at an angle to the longitudinal axis of said body, due to said body having been expanded between the partial and final hardening steps in the formation of the body.

13. A process for manufacturing containers adapted for use as casings which comprises shaping a mass of colloidal plastic material to form a tubular body having the micellae thereof substantially oriented to lie in a direction parallel with the longitudinal axis of the tubular body, partially hardening the tubular body, expanding the tubular body transversely of the longitudinal axis to rearrange a number of the micellae thereof to lie at an angle to the longitudinal axis of the tubular body, and thereafter completing the hardening of the tubular body while in expanded condition.

14. A process for manufacturing containers adapted for use as casings which comprises shaping a mass of colloidal plastic material to form a tubular body having the micellae thereof substantially oriented to lie in a direction parallel with the longitudinal axis of the tubular body, partially hardening the tubular body, inflating said tubular body with a fluid to expand the same transversely of the longitudinal axis and thereby rearrange a number of the micellae to lie at an angle to the longitudinal axis of the tubular body, and thereafter completing the hardening of the tubular body while in expanded condition.

15. A process for manufacturing containers adapted for use as casings which comprises shaping a mass of colloidal plastic material to form a tubular body having the micellae thereof substantially oriented to lie in a direction parallel with the longitudinal axis of the tubular body, partially hardening the tubular body, inflating said tubular body with a gas to expand the same transversely of the longitudinal axis and thereby rearrange a number of the micellae to lie at an angle to the longitudinal axis of the tubular body, and thereafter completing the hardening of the tubular body while in expanded condition.

16. A process for manufacturing containers adapted for use as casings which comprises shaping a mass of colloidal plastic material to form a tubular body having the micellae thereof substantially oriented to lie in a direction parallel with the longitudinal axis of the tubular body, partially hardening the tubular body, inflating said tubular body with a liquid to expand the same transversely of the longitudinal axis and thereby rearrange a number of the micellae to lie at an angle to the longitudinal axis of the tubular body, and thereafter completing the hardening of the tubular body while in expanded condition.

17. A process for manufacturing containers adapted for use as casings which comprises shaping a mass of colloidal plastic material to form a tubular body having the micellae thereof substantially oriented to lie in a direction parallel with the longitudinal axis of the tubular body, partially hardening the tubular body, expanding the diameter of the tubular body by inflating it within a limiting cylindrical member to thereby rearrange a number of the micellae to lie at an angle to the longitudinal axis of the tubular body and thereafter completing the hardening

of the tubular body while in expanded condition.

18. A process for manufacturing containers adapted for use as casings which comprises shaping a mass of nitrocellulose to form a tubular body having the micellae thereof substantially oriented to lie in a direction parallel with the longitudinal axis of the tubular body, partially hardening the tubular body, expanding the diameter

of the tubular body by inflating it within a limiting cylindrical member to thereby rearrange a number of the micellae to lie at an angle to the longitudinal axis of the tubular body and thereafter completing the hardening of the tubular body while in expanded condition. 5

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CERTIFICATE OF CORRECTION.

Patent No. 2,172,426.

September 12, 1939.

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It is hereby certified that error appears in the printed specification of the above numbered patent requiring correction as follows: Page 2, second column, line 1, for the word "exterior" read interior; line 37, after "extruded" insert a comma; and that the said Letters Patent should be read with this correction therein that the same may conform to the record of the case in the Patent Office.

Signed and sealed this 10th day of October, A. D. 1939.

Henry Van Arsdale,
Acting Commissioner of Patents.

(Seal)