

March 12, 1935.

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1,994,057

YARN AND METHOD FOR ITS PRODUCTION

Filed April 15, 1933

Fig. 1.

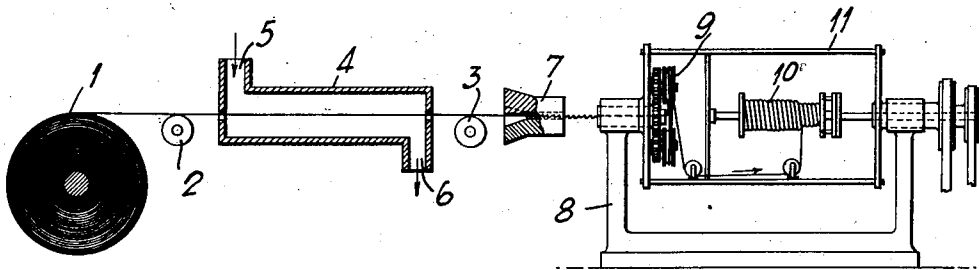


Fig. 2.

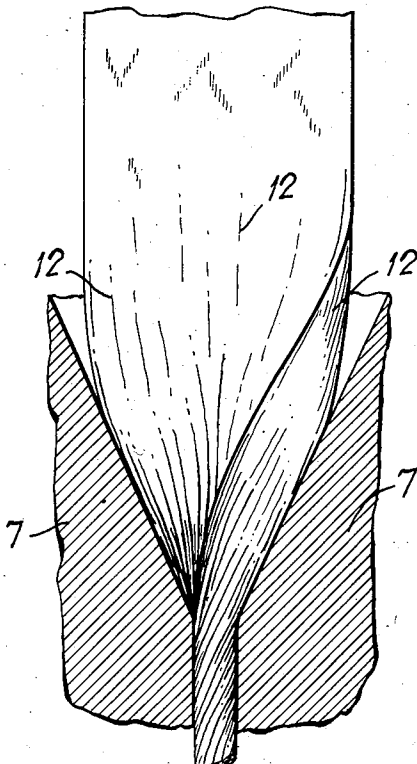


Fig. 3.

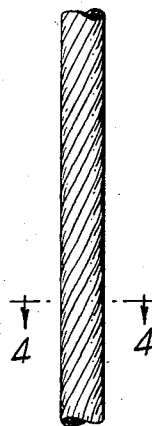


Fig. 5.

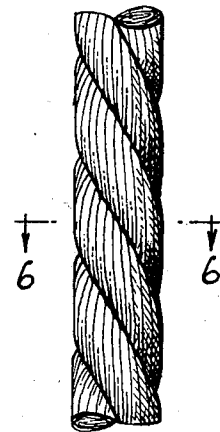


Fig. 4.



Fig. 6.



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UNITED STATES PATENT OFFICE

1,994,057

YARN AND METHOD FOR ITS PRODUCTION

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Application April 15, 1933, Serial No. 666,261

20 Claims. (Cl. 117—53)

The invention relates to an article of manufacture made of non-fibrous material and to a process of making the same. More particularly, it relates to a new and distinctive yarn, thread or strand adapted to be woven, braided or otherwise utilized in the textile and cordage arts, and includes correlated improvements and discoveries whereby such yarns, etc. may be produced, and the properties thereof enhanced.

It is a general object of the invention to provide a thread, yarn or strand produced from a flat thin strip of a non-fibrous material and being a substantially cylindrical compact mass which possesses the characteristics of flexibility and strength that adapt it for use in the textile and cordage arts.

Another object of the invention is to provide a thread, yarn or strand of non-fibrous cellulosic material, as regenerated cellulose, that is compact and has a high gloss and permanency of cross-sectional form in addition to the properties of flexibility and strength required of materials adapted to be woven, braided or otherwise utilized in the textile and cordage arts.

A further object of the invention is to provide a process for the manufacture of a substantially cylindrical compact thread, yarn or strand from a flat, thin strip of non-fibrous material in the presence of an agent imparting compactness and permanency of form to the thread, yarn or strand.

An additional object of the invention is to provide a process for the manufacture of yarns, threads or strands from a flat thin strip of a non-fibrous material by spinning or otherwise forming in the presence of a tumefying or swelling agent.

A still further object of the invention is to provide a yarn, thread or strand formed from a waste portion of a non-fibrous material, and a process for their utilization which may be readily economically and efficiently carried out on a commercial scale.

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

The invention accordingly comprises a process having the steps and the relation of the steps, one to another, and an article of manufacture possessing the features, properties and the relation of elements which are exemplified in the following detailed disclosure and the scope of the application of which will be indicated in the claims.

In the practice of the invention, the material used in forming the thread, yarn or strand may be a flexible sheet or web of non-fibrous material, particularly non-fibrous cellulosic material, such as regenerated cellulose; cellulose ethers, such as methyl cellulose, ethyl cellulose; and cellulose esters, such as nitrocellulose, cellulose ace-

tate, or gelatine, casein, synthetic plastics and the like. A strip of suitable width may be cut from the sheet or web and twisted or otherwise spun about its longitudinal axis or about an axis lying at an angle to the longitudinal axis of the strip to form a compact thread, yarn or strand of substantially cylindrical cross-section. It is especially adapted to utilize waste cuts in the form of flat, thin strips, particularly roll ends arising from the manufacture of films and sheets.

The preparation of a yarn is effected by a procedure in which a flat, thin strip of a non-fibrous material is first subjected to the action of a tumefying or swelling agent. The tumefied strips are then twisted, or otherwise spun, under tension to form a substantially cylindrical compact yarn which is thereafter detumefied whereby a greater compactness and permanency of cross-sectional form is imparted thereto. The thread or yarn thus formed may be woven, braided or otherwise formed into a fabric, or two or more such threads may be plaited or twisted with each other or with other materials to form a strand for twine, rope, and various other cordage materials, as disclosed in my copending U. S. application Serial No. 600,974.

For a fuller understanding of the nature and objects of the invention, reference should be made to the following detailed description taken in connection with the accompanying drawing, in which:

Fig. 1 is a diagrammatic view in elevation, partly in vertical section, illustrating certain steps of one modification of my improved process;

Fig. 2 is a top plan view of a strip of non-fibrous material just prior to its entrance into the nipper of the spinning device, showing the change in form which takes place at this point;

Fig. 3 represents a fanciful enlarged view of a yarn formed by twisting a strip of non-fibrous material about its longitudinal axis;

Fig. 4 is a sectional view taken along the line 4—4 of the yarn of Fig. 3;

Fig. 5 represents a strand consisting of two threads or yarns of non-fibrous material twisted together.

Fig. 6 represents a sectional view of the strand of Fig. 5, taken along the line 6—6 thereof.

In Fig. 1 there is represented diagrammatically an apparatus suitable for carrying out one modification of the process of the invention. A flat, thin strip of a non-fibrous material which may be taken from a roll 1 having a width, for example, of from $\frac{1}{2}$ to 3 inches, is passed by supporting rollers 2 and 3 through a tumefying chamber 4 wherein the strip is subjected to the action of a tumefying agent, preferably in vapor form. The tumefying agent may be admitted

to the chamber 4 by an inlet 5 and any condensate formed may be removed by an outlet 6. The intumescent strip is advanced through a spinning block or nipper 7 provided with means (not shown) for retarding the forward movement of the strip by friction. From the nipper 7 the twisted strip passes into a known spinning apparatus indicated collectively at 8 which is provided with means, such as the capstans 9, for pulling the yarn into the apparatus wherein it is wound upon a rotating bobbin 10 mounted on a rotating frame 11. The speed of the bobbin is adjusted with respect to the rate of delivery of the yarn so as to maintain the yarn under slight tension during winding.

The detumescence of the yarn preferably is carried out while maintaining the spun material under tension. For example, the yarn is wound more or less tightly upon a bobbin as above illustrated and the tumefying agent allowed or caused to evaporate. As the tumefying agent evaporates, the yarn has a tendency to shrink to a degree such that its compactness and permanency of cross-sectional form are enhanced. If desired, the evaporation may be effected by placing the bobbins in a suitable drying chamber maintained at a slightly elevated temperature.

The apparatus or means for applying the tumefying agent to the non-fibrous material may be modified, it will be realized, in various ways without transcending the scope of the invention. When the tumefying agent is employed in the vapor state the chamber therefor may be provided with heating means for maintaining the temperature of the chamber above the boiling point of the particular agent. Also, the agent may be circulated in a closed system including chamber 4 substantially without condensation.

If desired, the vapor chamber may be replaced by a vat designed to hold a liquid tumefying agent and which may be equipped with a wick, a freely rotatable roller or a brush for applying the agent to the non-fibrous material. When a vat is used, the amount of liquid tumefying agent applied should be varied in accordance with the nature and/or concentration of the agent. For example, with a dipping vat holding a tumefying agent having a rapid swelling action, the path should be shorter than for tumefying agents having a relatively slow action on the material. If desired, a brush or a doctor blade may be employed in conjunction with the vat and positioned to remove the excess of the tumefying agent from the material before the strip passes into the spinning apparatus.

The tumefying agent is preferably one which is substantially colorless and of low boiling point. For economy, the agent should be one which will evaporate at a substantial rate at atmospheric temperatures, although the spun material may be detumefied by evaporating the agent at a higher temperature.

The tumefying agent is selected with regard to the particular non-fibrous material to be employed. For regenerated cellulose, the following are suitable tumefying or swelling agents: water, aliphatic alcohols, such as methyl and ethyl alcohol; ketones, such as acetone; amino compounds such as ethyl amine, triethanolamine, etc. Suitable swelling agents for cellulose esters, as nitrocellulose, may comprise aliphatic alcohols, such as methyl and ethyl alcohol and mixtures of these alcohols with aromatic hydrocarbons, as benzene; ketones, as acetone, cyclohexanone and also mesityl oxide, and

aliphatic esters of alcohols and acids with a small number of carbon atoms, for example, ethyl acetate. The spinning of strips of cellulose ethers, cellulose oxyethers, gelatine, casein and synthetic plastics may be carried out after the strip has been subjected to the action of their respectively known tumefying agents.

Further, the tumefying agent is preferably a substance having a plasticizing effect in addition to a swelling effect, so that the quantities of the agent which remain in the material after detumescence will maintain the thread or yarn sufficiently flexible for weaving and like operations. When the tumefying agent does not have a plasticizing effect on the material, a plasticizer may be used in conjunction with the tumefying agent, or added directly to the latter as for example, by using a solution comprising a tumefying agent and a plasticizing agent. With regenerated cellulose one may employ a solution comprising, for example, water and a hygroscopic substance such as glycerine. The glycerine tends to maintain the yarn flexible by reason of the water absorbed thereby. With other non-fibrous materials, one may employ a solution containing a known swelling agent and a known plasticizer therefor. The tumefying agent may be applied in conjunction with an adhesive, a waterproofing or other coating material, or a dyeing or coloring material when such materials are compatible with the tumefying agent or may be rendered compatible therewith by the use of a mutual solvent.

Sheets or films having a coating which is impermeable to the swelling agent at room temperature may be used also. This may be accomplished by subjecting the coated material to the action of a tumefying agent in the vapor state while maintaining the material at a temperature at which the coating becomes permeable to the vapor of the agent. Thus, for example, with sheets or films of regenerated cellulose coated with a moistureproofing composition, the material is passed through the chamber 4 containing water vapor maintained at a temperature of 60° C. or above. At this temperature the moistureproof coating becomes permeable to the water vapor and the regenerated cellulose swells. After the tumefied coated material has been twisted or spun into a yarn, and the material has cooled to room temperature, the coating again becomes resistant to the diffusion of water vapor and retards evaporation of plasticizer so that the yarn remains flexible after the surface has dried. If desired, the material may be detumefied at an elevated temperature in order to remove a part of the entrapped swelling agent. This modification of the process of the invention permits use to be made of waste roll ends of moistureproofed non-fibrous material which, up to this time, have not been successfully made into yarns.

The action of the tumefying agent upon the non-fibrous material utilized in this invention can best be explained by reference to a particular material and its respective swelling agent. For example, when a strip of regenerated cellulose is subjected to the action of water, the swelling effect is believed to be the result of a combination of actions. In the first place, absorption of water occurs, due to the intramolecular attraction of the free hydroxyl groups in the cellulose molecules. Secondly, an intermolecular absorption occurs due to capillary action, the water molecules entering the pores between

the individual micelles comprising the non-fibrous structure. The absorption of water, therefore, changes both the size of the micelles as well as the pore space between the micelles which are thousands of times more numerous in non-fibrous material than the cells in fibrous material. Accordingly, there is a substantial change in dimensions; the strip of regenerated cellulose becomes from 2% to 5% thicker, from 2% to 15% wider, and from 5% to 10% longer. Spinning under tension may produce an additional increase of 2% to 5% in length.

When a sheet of tumefied, regenerated cellulose is twisted or spun under tension, the material readily becomes crimped or pleated into a multiplicity of small folds, as shown at 12 in Fig. 2, the contiguous layers of which coalesce and adhere strongly. When detumefication occurs or is brought about in the finished thread or yarn, the swelling agent is lost, both from the combination with the molecules and from the pores. During detumefication, the yarn becomes smaller in diameter, while the tendency to shorten, places the twisted overlapping surfaces under a substantial pressure, thus increasing the compactness and permanency of form. For example, when a given length of yarn made from a flat, thin strip of regenerated cellulose by the process of this invention is detumefied free of tension, the yarn has been found to shrink an amount equal to about 5% of its original length. If, however, such a yarn be maintained under tension so that it cannot shorten, the diameter of the yarn decreases and the twist imparted by the spinning operation becomes more compact. If detumefication is carried out while the yarn is wound upon the bobbin, suitable tension will be obtained to give a compact material having a permanent cross-sectional form.

The action of a tumefying agent upon non-fibrous material is materially different from the action of water upon fibrous material. To make twine of paper, it has been proposed to moisten or wet a strip of paper, twist the moistened strip and allow it to dry. The water taken up by the paper is held chiefly by capillary action between the fibres, although a small amount of water enters the individual cells by osmosis and this water enlarges the cells transverse of their length and shortens them. The absorption of water, therefore, shortens the strip and thickens it. It is practically impossible to spin the wet fibrous material under substantial tension as herein described, for the reason that the material has substantially no elasticity in the moistened condition.

Moreover, the changes which occur in the drying of wet paper twine are in direct contrast to those occurring in the drying of non-fibrous yarns made according to this invention. In paper twine the cells lose their absorbed water and flatten, and there is an appreciable increase in the length of the twine during drying. The compactness of dried paper twine is therefore less than that of the same twine in the moistened condition.

When a strip of non-fibrous material is treated as above described, the novel product has a gloss; a compactness, and a permanency of cross sectional form not possessed by yarns of fibrous or non-fibrous material heretofore known.

The threads or yarns produced according to this invention may be twisted together in overlapping relation or one strip may be twisted about its longitudinal axis and a second strip

twisted about the first at an angle to the longitudinal axis of the first strip. One or more strips may be spun about a suitable core of fibrous material or metal to produce a twine, cord or rope of novel properties, and a plurality of the yarns woven, plaited, braided or otherwise formed into a fabric with or without the use of textile or other fibrous yarns. The woven fabric may comprise the novel yarn of this invention in both warp and weft, or it may have a warp or weft of a textile yarn such as cotton, twine, wool, silk, metal, rayon, linen, flax, jute, ramie and the like, or combinations of any of them. The novel, non-fibrous yarn may be dyed, de-lustered or waterproofed before or after being fashioned into a textile or a cordage product.

Fabrics produced with the novel yarn of this invention have a distinctive resilience, high gloss, attractive appearance, exceptional wearing qualities and a resistance to tearing which renders them superior to straw, cane, rattan or fabrics formed wholly of textile yarns. The fabrics of this invention are especially adaptable by reason of the above properties for seat, floor and upholstery coverings, draperies, wall coverings, baskets, mats, window shades, shoes and wearing apparel or any of the variety of uses to which fabrics, cords or ropes may be put.

Since certain changes may be made in the above article and the improved process of producing the same and different embodiments of the invention could be made without departing from the scope thereof, 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.

In the appended claims, the expression "spinning" is not to be limited to that operation of the cordage art which is described by this term and which in that art includes the feature of drawing as well as twisting. The term "spinning" as used herein is intended to cover all operations of twisting or convoluting the non-fibrous material, which operations may or may not involve drawing or stretching the material.

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

1. A process of producing a material adapted to be utilized in the textile and cordage arts, which comprises subjecting a flat, thin strip of non-fibrous material to the action of a tumefying agent, spinning the intumescent material to a compact yarn, and detumefying said yarn.

2. A process of producing a material adapted to be utilized in the textile and cordage arts, which comprises subjecting a flat, thin strip of a non-fibrous material to the action of a tumefying agent, spinning the intumescent material under tension to a compact yarn, and detumefying said yarn.

3. A process of producing a material adapted to be utilized in the textile and cordage arts, which comprises subjecting a flat, thin strip of a non-fibrous material to the action of a tumefying agent in the vapor state, spinning the intumescent material under tension to a compact yarn, and detumefying said yarn.

4. A process of producing a material adapted to be utilized in the textile and cordage arts, which comprises subjecting a flat, thin strip of a non-fibrous cellulosic material to the action of a tumefying agent, spinning the intumescent

material under tension to a compact yarn, and detumefying said yarn.

5 A process of producing a material adapted to be utilized in the textile and cordage arts, which comprises subjecting a flat, thin strip of a non-fibrous cellulosic material to the action of a tumefying agent, spinning the intumescent material under tension to a compact yarn, and detumefying said yarn at an elevated temperature while under tension.

10 6. A process of producing a material adapted to be utilized in the textile and cordage arts, which comprises subjecting a flat, thin strip of regenerated cellulose to the action of a tumefying agent, and spinning the intumescent material to a compact yarn.

15 7. A process of producing a material adapted to be utilized in the textile and cordage arts, which comprises subjecting a flat, thin strip of regenerated cellulose to the action of a tumefying agent, spinning the intumescent material to a compact yarn, and detumefying said yarn.

20 8. A process of producing a material adapted to be utilized in the textile and cordage arts, which comprises subjecting a flat, thin strip of regenerated cellulose to the action of water in the vapor state, spinning the intumescent material under tension to a compact yarn, and removing water at an elevated temperature while under tension.

30 9. A process of producing a material adapted to be utilized in the textile and cordage arts, which comprises subjecting a flat, thin strip of regenerated cellulose to the action of a tumefying agent including a plasticizer, spinning the intumescent material under tension to a compact yarn, and detumefying said yarn without removing said plasticizer.

35 10. A process of producing a material adapted to be utilized in the textile and cordage arts, which comprises subjecting a plurality of flat, thin strips of non-fibrous cellulosic material to the action of a tumefying agent, spinning the intumescent material under tension to a compact yarn, and detumefying said yarn.

40 11. A process of producing a material adapted to be utilized in the textile and cordage arts, which comprises subjecting a flat, thin strip of non-fibrous material having an impermeable coating thereon, to the action of a tumefying agent while maintaining the coated material at a temperature at which the coating is permeable to said agent, spinning the intumescent material to a compact yarn, and detumefying said yarn.

45 12. A process of producing a material adapted to be utilized in the textile and cordage arts, comprising subjecting a flat, thin strip of regenerated cellulose having a moistureproof coating thereon to the action of water vapor at an elevated temperature, spinning the intumescent material under tension to a compact yarn, and detumefying said yarn at an elevated temperature while under tension.

50 13. A process of producing a material adapted to be utilized in the textile and cordage arts, which comprises subjecting a flat, thin strip of non-fibrous material to the action of a tumefying agent, crimping the intumescent strip to produce therein a multiplicity of folds, spinning the crimped strip under tension to a substantially cylindrical compact yarn, and detumefying said yarn.

55 14. A process of producing a material adapted to be utilized in the textile and cordage arts,

which comprises subjecting a flat, thin strip of regenerated cellulose to the action of water in the vapor state, crimping the intumescent strip to produce therein a multiplicity of folds, spinning the crimped strip under tension, to a substantially cylindrical, compact yarn, and detumefying said yarn at an elevated temperature while maintaining the yarn under tension.

15 15. A process of producing a material adapted to be utilized in the textile and cordage arts, which comprises subjecting a flat, thin strip of non-fibrous material having an impermeable coating thereon, to the action of a tumefying agent while maintaining the coated material at a temperature at which the coating is permeable to said agent, crimping the intumescent strip to produce therein a multiplicity of folds, spinning the crimped strip under tension to a substantially cylindrical, compact yarn, and detumefying said yarn.

20 16. As an article of manufacture, a flexible yarn adapted to be utilized in the textile and cordage arts, comprising a twisted strip of plasticized non-fibrous, cellulosic material, the strip having a multiplicity of lengthwise folds and the contiguous surfaces of the material being coalesced so as to form a substantially solid mass having a permanent cross-sectional form.

25 17. As an article of manufacture, a flexible yarn adapted to be utilized in the textile and cordage arts, comprising a twisted strip of plasticized non-fibrous material having a moistureproof coating thereon, the strip having a multiplicity of lengthwise folds and the contiguous surfaces of the material being coalesced so as to form a substantially solid mass having a permanent cross-sectional form, the moistureproof coating retarding the evaporation of the plasticizer so as to maintain the flexibility of the yarn.

30 18. As an article of manufacture, a flexible yarn adapted to be utilized in the textile and cordage arts, comprising a twisted strip of plasticized non-fibrous, cellulosic material having a moistureproof coating thereon, the strip having a multiplicity of lengthwise folds and the contiguous surfaces of the material being coalesced so as to form a substantially solid mass having a permanent cross-sectional form the moistureproof coating retarding the evaporation of the plasticizer so as to maintain the flexibility of the yarn.

35 19. As an article of manufacture, a flexible yarn adapted to be utilized in the textile and cordage arts, comprising a twisted strip of regenerated cellulose having a moistureproof coating thereon, the strip having a multiplicity of lengthwise folds and the contiguous surfaces of the material being coalesced so as to form a substantially solid mass having a permanent cross-sectional form the moistureproof coating retarding evaporation so as to maintain the flexibility of the yarn.

40 20. As an article of manufacture, a yarn adapted to be utilized in the textile and cordage arts, comprising a twisted strip of plasticized regenerated cellulose having a moistureproof coating thereon, the strip having a multiplicity of lengthwise folds and the contiguous surfaces of the material being coalesced so as to form a substantially solid mass having a permanent cross sectional form, the moistureproof coating retarding the evaporation of the plasticizer so as to maintain the flexibility of the yarn.