

Jan. 11, 1938.

J. P. SMITH

2,105,273

APPARATUS FOR MANUFACTURING CELLULOSE COATED AND IMPREGNATED FIBROUS TUBES

Filed June 8, 1935

5 Sheets-Sheet 1

Fig. 2.

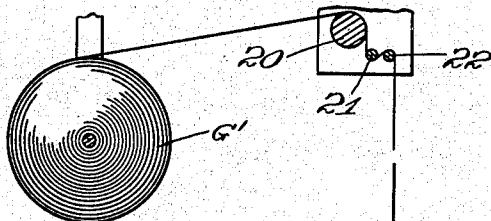
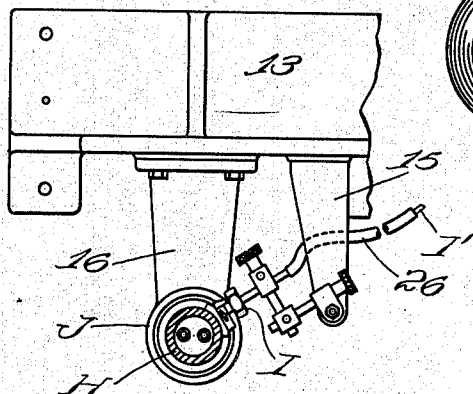
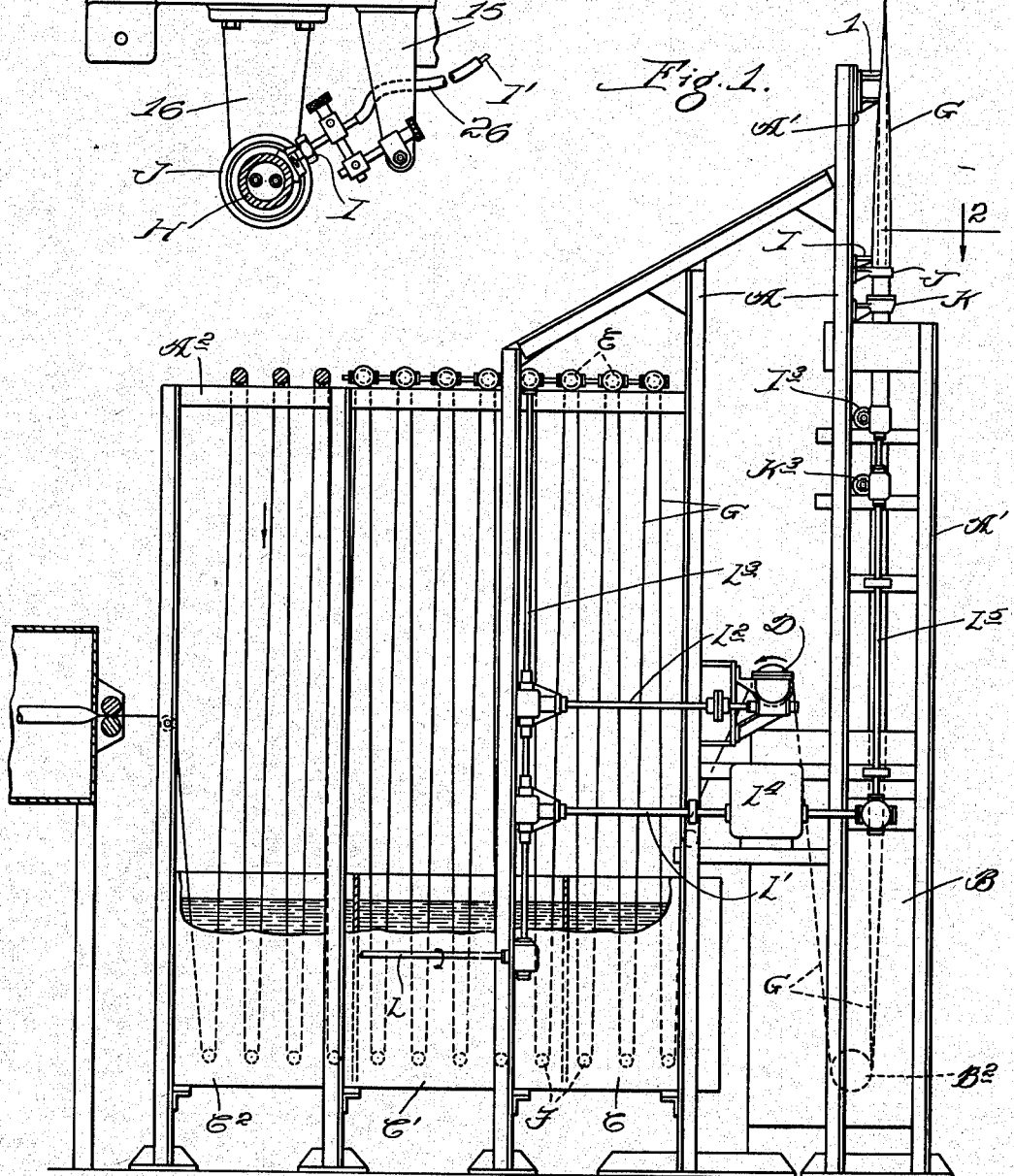


Fig. 1.



Inventor:
John Paul Smith.
By Dymally, Lee, Ehrlich & Mills.
Attys.

Jan. 11, 1938.

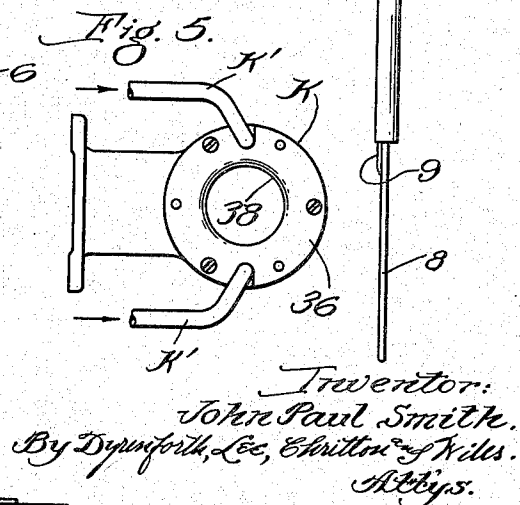
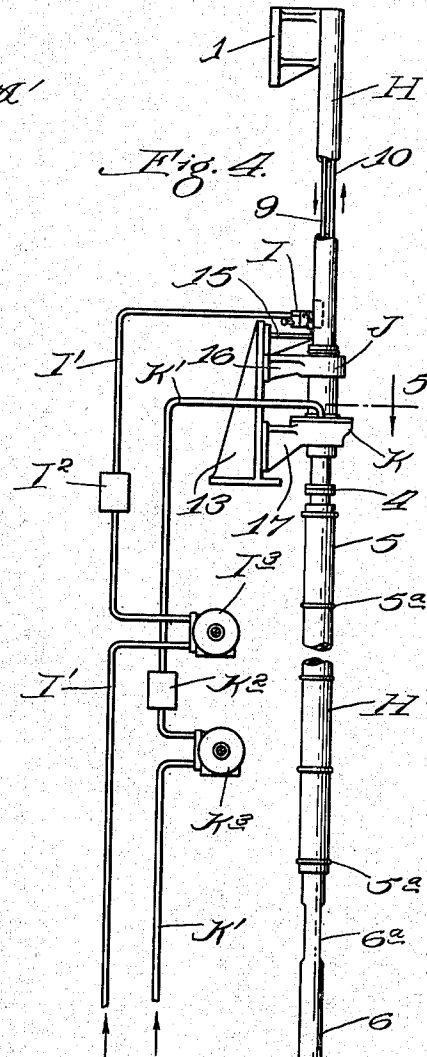
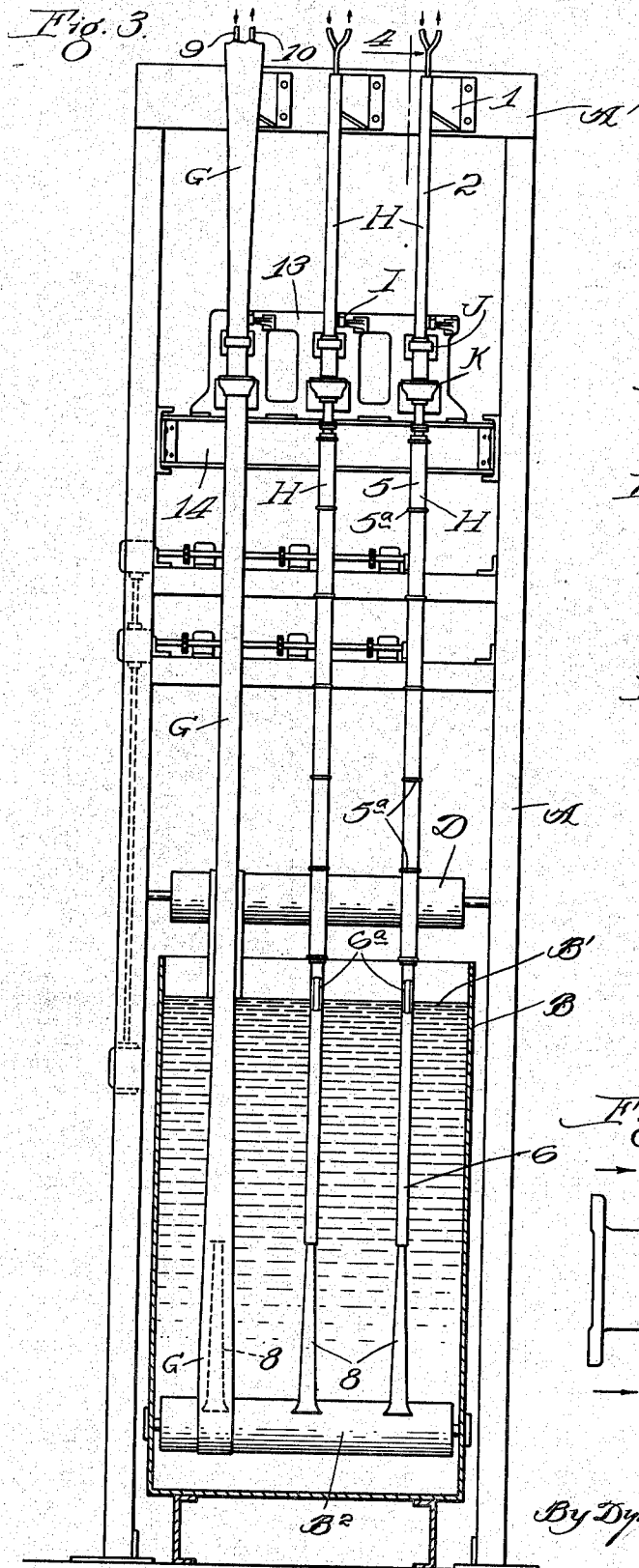
J. P. SMITH

2,105,273

APPARATUS FOR MANUFACTURING CELLULOSE COATED AND IMPREGNATED FIBROUS TUBES

Filed June 8, 1935

5 Sheets-Sheet 2



Inventor:
John Paul Smith.
By Dymally, Lee, Whitton & Niles.
Attys.

Jan. 11, 1938.

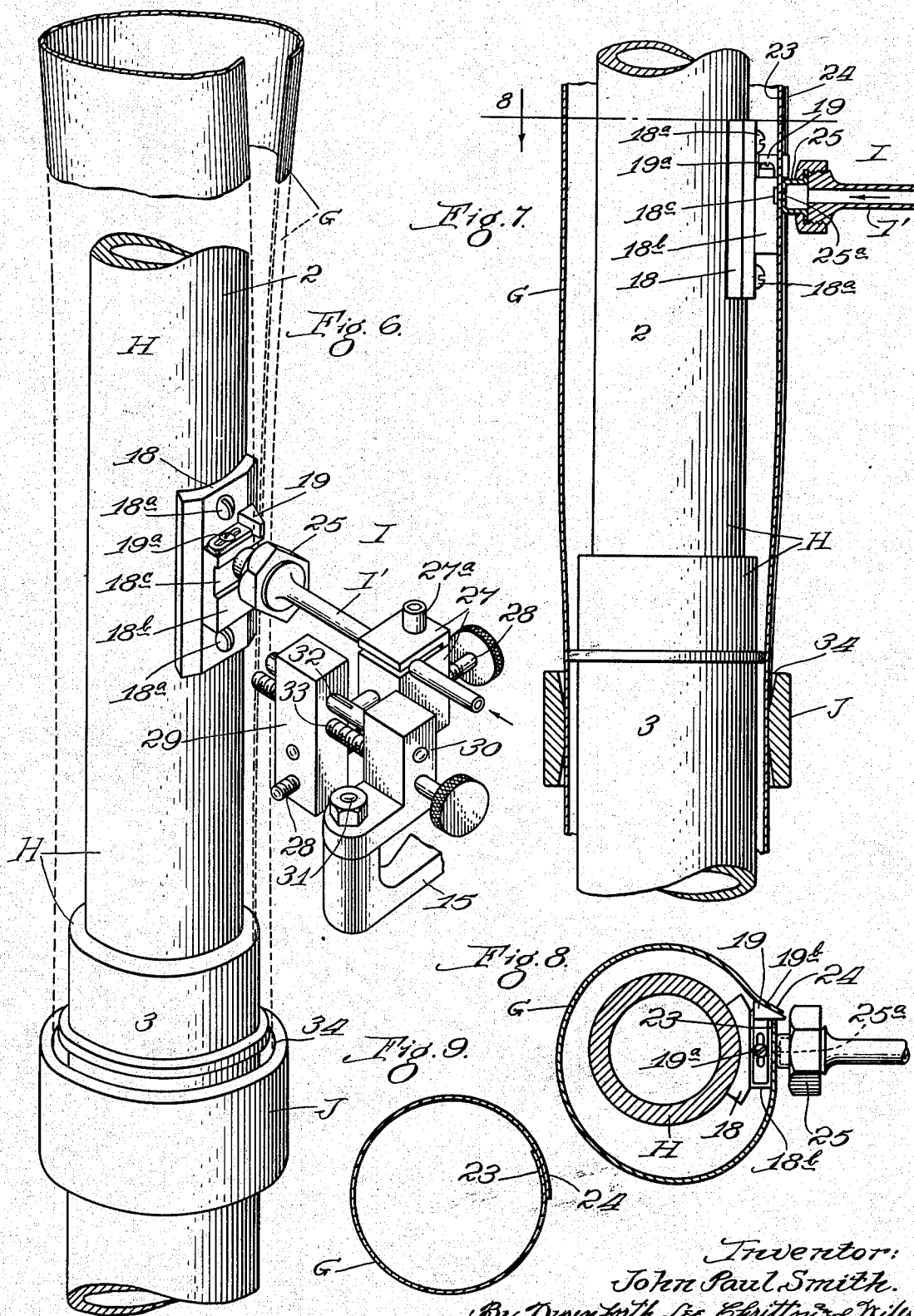
J. P. SMITH

2,105,273

APPARATUS FOR MANUFACTURING CELLULOSE COATED AND IMPREGNATED FIBROUS TUBES

Filed June 8, 1935

5 Sheets-Sheet 3



Inventor:
John Paul Smith.
By Dymally, Lee, Ebbert & Mills,
Attorneys.

Jan. 11, 1938.

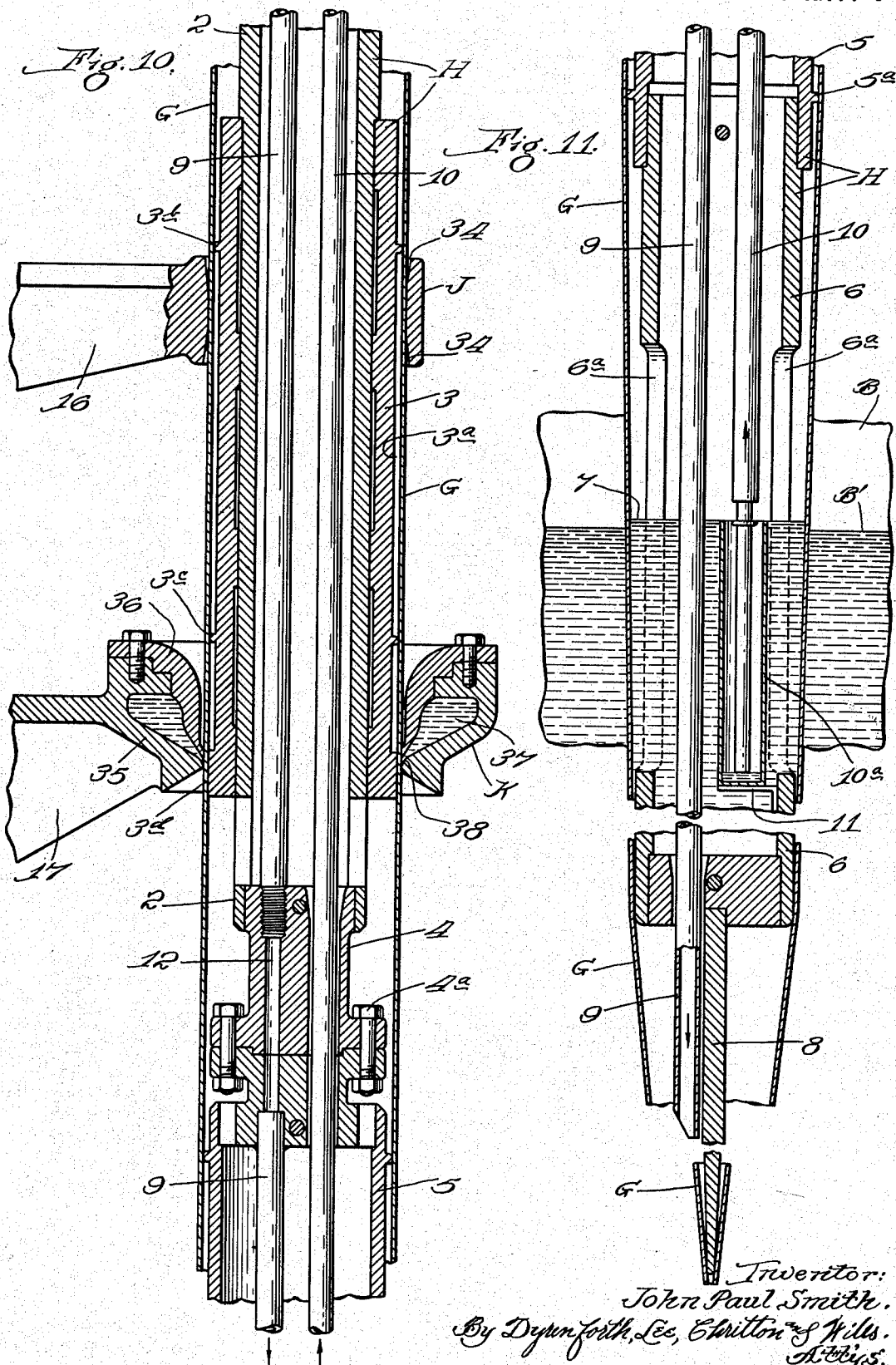
J. P. SMITH

2,105,273

APPARATUS FOR MANUFACTURING CELLULOSE COATED AND IMPREGNATED FIBROUS TUBES

Filed June 8, 1935

5 Sheets-Sheet 4



Jan. 11, 1938.

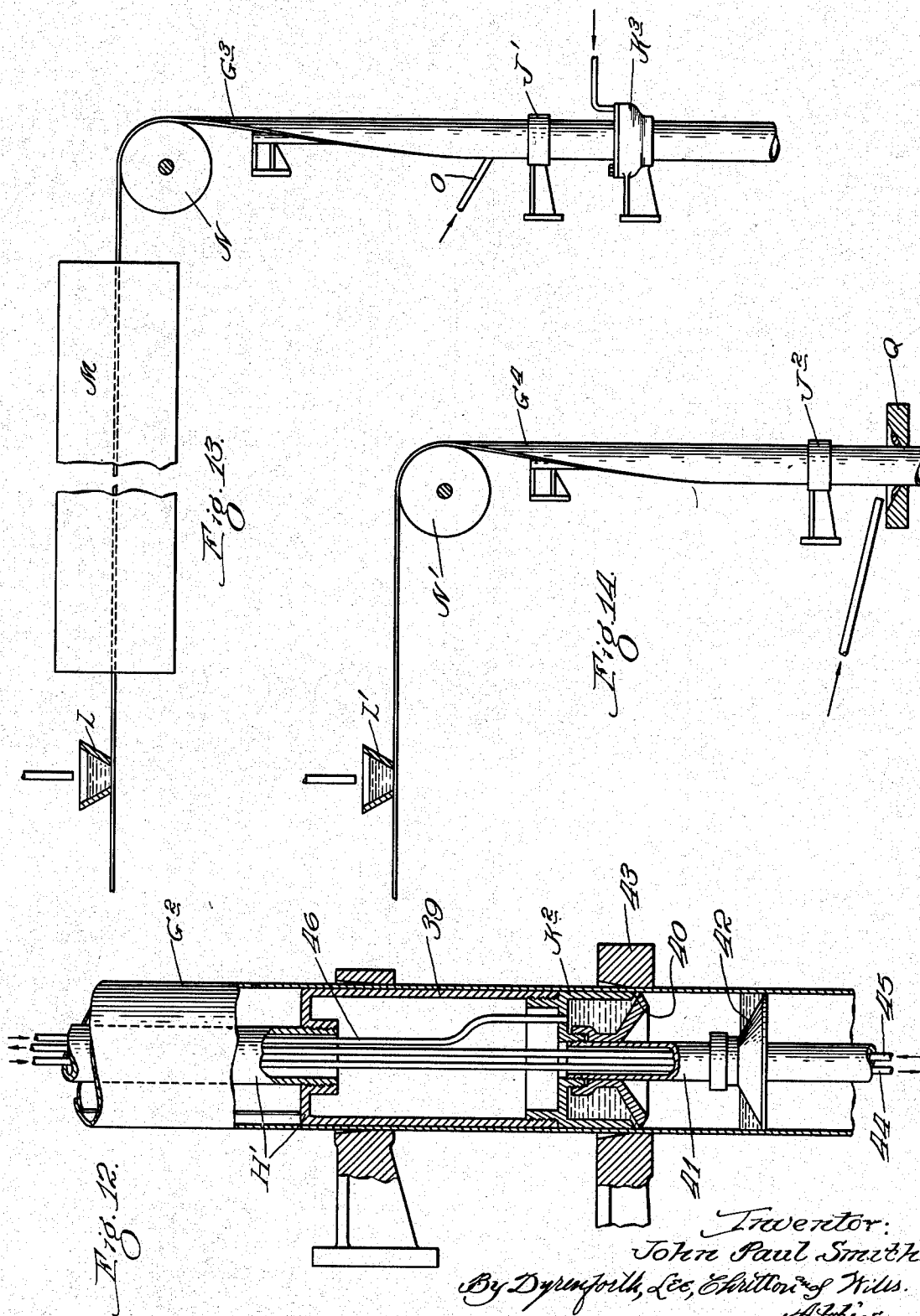
J. P. SMITH

2,105,273

APPARATUS FOR MANUFACTURING CELLULOSE COATED AND IMPREGNATED FIBROUS TUBES

Filed June 8, 1935

5 Sheets-Sheet 5



Inventor:
John Paul Smith.
By Dyrup, Lee, Chittenden & Hill.
Attys.

UNITED STATES PATENT OFFICE

2,105,273

APPARATUS FOR MANUFACTURING CELLULOSE COATED AND IMPREGNATED FIBROUS TUBES

John Paul Smith, Chicago, Ill., assignor to The Visking Corporation, Chicago, Ill., a corporation of Virginia

Application June 8, 1935, Serial No. 25,686

24 Claims. (Cl. 93—82)

The present invention pertains to apparatus adapted to the economical production of a combined fibrous tube and a matrix of cellulose, or cellulose derivative, in which the fibrous tube is embedded.

In accordance with the present invention, in its preferred practice, a thin, long-fibred paper strip is curved about a longitudinal axis into the form of a tube with overlapping longitudinal margins, the margins are pasted together, a cellulose derivative coating is applied to the strip, either before or after it is formed into a tube, and the formed and pasted tube is drawn through a regenerating bath which effects regeneration of the coating, that is, converts it into cellulose, or cellulose hydrate, and the tube is then drawn through a purifying water bath, and then, if desired, through a water-bath containing a small percentage of a hygroscopic agent, such as glycerine. The tube is then dried, preferably by passing it in inflated condition through a heated drying chamber.

While the paper strip may have the cellulose derivative coating applied thereto prior to forming the strip into a tube and pasting its overlapping margins together, the coating may be applied after the tube has been formed and pasted. In either event, it is preferred to draw the coated tube continuously through a regenerating medium, or through a coagulating and regenerating medium, thence through a purifying bath, and finally through a drier; and, in this operation, to form successive portions of the strip, progressively, into tubular form and effect the pasting operation of the margins of the tube as the tube formation takes place.

I have found, for example, that it is possible to apply to a thin, bibulous strip of paper of fragile character a viscose coating, and pass the coated strip, formed into a tube, with the margins pasted together, through a coagulating and regenerating bath, thence through a purifying bath, thence through a bath containing a small percentage of glycerine, and finally through a drier. A thin, fragile strip of paper, with such a coating applied, may be subjected to a continuous drawing operation of the character stated.

My preferred practice, more specifically stated, is to draw a strip of paper from a roll, subject it to curvature about a longitudinal axis to form a tube with overlapping longitudinal margins, apply a strip of viscose paste to the underlying margin, pass the tubular formation through a forming ring which effects pasting the margins, thence through a viscose-coating ring which applies a coating to the outer surface of the tube, pass the coated tube (over a depending mandrel) downwardly into a coagulating and regenerating bath, thence about a roller in the lower portion

of the bath, and thence upwardly and then through additional baths, one of which may be a purifying bath and another a bath containing a small percentage of glycerine. The paper tube, now bearing a regenerated cellulose coating, may be passed directly through a drier; or, it may be stored on rolls, or otherwise, and passed from the storage member through a drier. Finally, the dried, coated tube may be cut into desired lengths. Such tubes may serve as containers for sausages, meats, fruits, or other articles of food, or for any desired purpose. Tubes produced in this manner are tough and strong. They may be made translucent or semi-transparent; or they may be made opaque, if desired.

The accompanying drawings illustrate the improved process and suitable apparatus for conveniently practicing the process, by a preferred method, and modifications thereof.

In the drawings—

Fig. 1 is a broken side elevational view of improved apparatus adapted to the practice of the preferred process; Fig. 2, a broken sectional view, on an enlarged scale, taken as indicated at line 2 of Fig. 1, showing the seam-paster in plan; Fig. 3, an end elevational view of the apparatus, viewed from the right of the apparatus as shown in Fig. 1, the coagulating and regenerating tank being shown in section, this view showing a battery of mandrels for enabling a plurality of tubes to be formed in the same apparatus; Fig. 4, a skeleton vertical sectional view taken as indicated at line 4 of Fig. 3, showing one of the mandrels and attendant parts; Fig. 5, a plan view of one of the coating-applying rings, the view being taken as indicated at line 5 of Fig. 4; Fig. 6, a broken upper perspective view illustrating one of the seam-pasters and its associated mandrel, it being noted that an enlargement of the mandrel and a forming-ring encircling said enlargement appear at the lower portion of the figure; Fig. 7, a broken vertical sectional view, illustrating the application of a strip of paste to the underlying margin of the tubular paper member, the lower portion of the figure showing the manner in which the forming-ring compresses the seam in the pasting operation; Fig. 8, a horizontal section taken as indicated at line 8 of Fig. 7; Fig. 9, a sectional view of the pasted tube; Fig. 10, a broken vertical sectional view illustrating the paper tube undergoing the application of an external coating, this view showing also the pipes which pass downwardly through the mandrel and serve to maintain a constantly renewed internal bath within the paper tube; Fig. 11, a similar sectional view taken at a lower point and showing the relation of the internal bath to the external bath, and showing also an internal tube-flattening member forming an extension of the mandrel, from which the tube is delivered in substantially

flattened condition to the roller near the bottom of the bath (see Fig. 3); Fig. 12, a broken vertical sectional view illustrating a modification, in which provision is made for applying an internal coating to the paper tube; Fig. 13, a view illustrating a modification of the process, in which a coating is applied to one surface of a flat strip, the strip is then passed through a drier (without effecting regeneration), the coated strip is then formed into a tube and sprayed with a solvent to soften the coating, the margins are pasted by passing through a forming-ring, and the tube is then in condition to be drawn through the regenerating bath; and Fig. 14, a view illustrating another modification of the process, in which a flat strip is coated, is then formed into a tube without being subjected to a drying operation, the tube is pasted, and the tube is then in condition to be passed through the coagulating and regenerating bath.

Referring to the apparatus illustrated in Figs. 1-11, and describing said apparatus in appropriate terms with reference to the application of a viscose coating, practiced in accordance with the preferred method, A designates a suitable frame which is provided with a standard A' adapted to support mandrels; B, a tank containing a coagulating and regenerating bath B', said tank having mounted in its lower portion a roller B² about which the regenerated, or partially regenerated, coated tubes may pass as they leave the mandrels; C, C' and C², a series of baths which may serve, in the order named, for completing the regeneration, for purifying the regenerated coated tubing, and for introducing a small percentage of glycerine, for example, into the coated fabric; D, a roller disposed above the rear portion of the tank B; E, a series of rollers mounted on a portion of A² of the frame at a considerable distance above the tanks, C, C' and C²; F, rollers mounted in the lower portions of the tanks just mentioned; G, a fibrous strip undergoing transformation into a cellulose-coated tube, the tube passing from the mandrel about the roller B², thence about the roller D, and then threaded about the rollers E and F in the manner illustrated in Fig. 1; H, a series of mandrels, shown as three in number (Fig. 3), suspended from the upper portion of the standard A' and depending into the bath B'; I, a seam-paster associated with each mandrel, the paster having connected therewith a supply pipe I', equipped with a strainer I² and with a pump I³; J, a forming-ring associated with each mandrel and serving to complete the pasting; K, a coating-applying ring associated with each mandrel and receiving a viscose supply through pipes K' (Figs. 4 and 5), these pipes being equipped with strainers K² and pumps K³; and L, (Fig. 1) a main drive-shaft driven from any suitable source (not shown) serving to actuate shafts L', L² and L³, the shaft L' serving, through the medium of a gear-ratio-changer L⁴, to actuate a shaft L⁵ from which the shafts which actuate the pumps I³ and K³ are driven; the shaft L² serving to actuate the roller D; and the shaft L³ serving to actuate the rollers E.

It will be understood that the rollers D and E are thus geared together so that they operate at the proper speed to feed the tubes through the apparatus; also, that the pumps I³ and K³ are so actuated as to positively deliver measured quantities of viscose to the seam-paster I and the coating-applying device K.

In applying a viscose coating to a paper tube,

I have found that one may employ a so-called viscose solution of the same character, composition, viscosity, etc., as is now commonly employed in the manufacture of extruded regenerated cellulose tubes. While commonly known as viscose solution, it is, perhaps, more properly defined as an aqueous dispersion of cellulose-sodium-xanthate; and, perhaps, there may be some free cellulose in the dispersion. Reference to other cellulose derivatives will be made later.

The frame A may be of any suitable construction. The tanks employed may be of any suitable construction, and may be made of non-corrosive materials, or may have non-corrosive linings. The rollers, pipes, etc., may be composed of material which will withstand corrosive action.

A description of one of the mandrels H and attendant parts, as preferably constructed, will now be given. The standard A' carries suitable brackets 1 from which the mandrels are suspended. Each mandrel preferably comprises a mandrel pipe 2 depending from a bracket 1; a larger pipe-section 3 secured on the lower end portions of the pipe 2 and coating with the forming-ring J and the coating-applying device K, as shown in Fig. 10; a coupling 4 secured to the lower extremity of the pipe 2, a little below the lower end of the enlarged pipe-section 3; a tubular mandrel-section 5 secured to and depending from the coupling 4, the member 5 being provided with external rings, or flanges, 5^a with which the inner surface of the paper tube contacts as the tube descends into the bath; a smaller diameter tubular section 6 secured to and depending from the lower end of the section 5, as shown in Fig. 11, the section 6 being provided with lateral openings 6^a which permit the internal bath, designated 7, to form a support for the inner wall of the paper tube; and an internal tube-flattening device 8 depending from the lower end of the pipe-section 6, the widened lower extremity of the member 8 being in position to permit the flattened tube to pass therefrom onto the lower roller B², as shown in Fig. 3.

Housed within each mandrel H is an internal bath-supply pipe 9 and a return suction-pipe 10, the lower end of the latter extending into an overflow-cup 10^a (Fig. 11) which is supported on a bracket 11 mounted internally in the lower portion of the pipe-section 6. The upper edge of the cup 10^a is preferably so located that the level of the internal bath 7 will be slightly above the level of the external bath B', as shown in Fig. 11. Liquid overflowing into the cup 10^a may be exhausted through the pipe 10 by any suitable exhaust device (not shown).

The pipe 9 (Fig. 10) comprises two sections which are detachably connected with the coupling 4, these sections being in communication with each other through a bore 12 extending vertically through the coupling. The coupling 4 is, for convenience, a two-part coupling, the parts being connected by bolts 4^a. The lower end of the internal bath supply pipe 9 terminates some distance above the lower end of the tube-expander 8. As shown, the paper tube G becomes constricted or flattened as the tube approaches the roller B², and finally the tube is sealed as it passes about the roller B². It will be understood, accordingly, that the internal bath 7 fills the paper tube from the point where it passes about the roller to the level shown in Fig. 11.

The internal bath pipes 9 and 10 enter the mandrel through its upper end. These pipes may be supported in any suitable manner (not shown),

and any suitable means (not shown) may be employed for feeding coagulating and regenerating fluid through the pipe 9 to the internal bath.

The seam-paster I, the forming ring J, and the coating-applying device K are carried (Figs. 2 and 3) on a mounting 13 supported by a cross-member 14 of the standard A', and are supported, respectively, by brackets 15, 16, and 17 carried by the mounting 13.

The seam-paster I will be understood from Figs. 6-8. The mandrel H carries a bearing-plate 18 which is secured to the mandrel by screws 18^a. This plate has an enlargement which is provided with an outwardly presented face 18^b, crossed by a groove 18^c. The underlying margin of the paper strip G is adapted to bear on the face 18^b as the strip is drawn downwardly. Carried by the enlargement mentioned is a small vertical guide-member 19 having a slotted horizontal shank resting on the upper wall of the enlargement and adjustably secured in position by a screw 19^a. The member 19 presents a vertical guide 19^b which is disposed in an oblique plane.

The paper strip G is taken from a roll G' and passed about guide rods 20, 21 and 22 (Fig. 1) located a considerable distance, preferably from 5 feet to 15 feet above the upper end of the mandrel. The paper strip is moderately tensioned in its passage about the guides mentioned, and is suspended in such manner that the paper may be caused to assume tubular form without objectionable strain as the paper passes downwardly over the mandrel. In Fig. 8, the underlying lateral margin of the paper strip is designated 23, and the overlying margin is designated 24. It will be seen that the margin 24 is guided by the member 19 and held away from the margin 23 while the band or strip of paste is being applied to the margin 23.

The paste-applying device comprises a nozzle 25, forming a terminal for the supply-pipe I'. As shown in Fig. 2, a hose-connection 26 may be introduced in the line I' to permit freedom of movement in adjusting the nozzle. The section of the pipe I' which carries the nozzle is adjustably mounted in a block 27 which, in turn, is adjustably carried by a screw 28 which has threaded connection with a block 29. The block 29, in turn, is adjustably connected with a block 30 having a shank connected with a nut-equipped threaded stud 31 which forms the upturned extremity of the bracket 15. The connections between the blocks 29 and 30 are shown as comprising a guide-pin 32 and an adjusting screw 33.

The block 27 is a two-part block, the upper section serving to clamp the pipe I' to the lower section. A clamping screw 27^a accomplishes the purpose.

The supporting means for the nozzle is designed to permit universal adjustment, and also permit the nozzle to be withdrawn from operative position, when desired. Any suitable means for accomplishing this purpose may be employed.

As will be understood from Figs. 7 and 8, the nozzle tip is provided with a small horizontal slot 25^a which is adapted to apply a narrow band of paste to the underlying margin 23 of the paper before the margins are brought into overlapped position. This slot-like orifice preferably is located opposite the recess 18^c of the bearing-plate 18, thus allowing a certain flexibility at this point. As the tubular strip passes downwardly to the forming ring J, the overlap is completed; and in passing between the forming-ring J and

the enlarged section 3 of the mandrel, the overlapped margins are ironed together and the pasting of the seam is completed. The ring J preferably has its bore flaring somewhat at the upper and lower edges as indicated at 34.

The paper tube, in its completely pasted condition, is shown in Fig. 9.

As shown in Fig. 10, the coating-applying device K preferably comprises an annular member 35 carried by the bracket 17, and a companion annular member 36 detachably mounted on the member 35. These ring-members are formed to provide between them an annular viscose-chamber 37; and the members are so formed as to provide between their inner edges an annular discharge orifice 38. The parts are of suitable material to withstand corrosive action. The pasted paper tube passes downwardly through the coating-applying device K, where an external coating of a cellulose derivative is applied to the tube. Reference has heretofore been made to the pipes K' (Fig. 5) through which the cellulose derivative is supplied to the chamber 37. The coating material, preferably viscose, is pumped in measured quantity into the chamber 37 and forced through the annular orifice, thus insuring a substantially uniform coating. Preferably, also, the paste supplied to the seam-paster is viscose.

The paper tube is progressively formed, as described, and is progressively passed through the regenerating bath B' and then through the subsequent baths, and finally, by continuous movement, if desired, through a drier.

In Fig. 3, the descent of a formed tube G into the bath B' is illustrated in the left-hand portion of the figure; and in Fig. 11, the relative levels of the internal bath 7 and the external bath B', as preferably maintained, are illustrated. It has been found desirable to maintain a supporting liquid column within the paper tube; and preferably such liquid column is a regenerating fluid, or, in the case of viscose, a fluid containing both coagulating and regenerating agents. The internal bath, as well as the external bath, tends to permeate the paper and coagulate and regenerate the viscose.

Where the cellulose derivative employed is viscose, it is preferred to coagulate and partially regenerate the viscose in the bath B'. Any gases evolved outside the paper tube will escape freely to the atmosphere. Such gases as may be evolved within the paper tube are exhausted through pipe 10, that is, through the initial end of the tubular mandrel. In manufacturing a tube from thin paper in accordance with the process, it is preferred to use a coagulating and regenerating bath comprising about 16% to 18% ammonium sulphate and about 2% to 4% sulphuric acid, in water. It has been found that such a bath, while giving fairly rapid regeneration in the tank B, avoids any violent evolution of gases, and thus tends to the production of a uniform regenerated coating.

The temperature of the bath B' may conveniently be about 30° to 35° C. If a higher temperature be employed, the acidity may be lowered somewhat. A bath of the character specified above works very well in dealing with paper having a thickness of, say, about .002. Where a stronger fabric is employed, it may become desirable to increase the acidity of the bath. It is possible, for example, to obtain substantially complete regeneration within the bath B' by employing an acidity of from about 5% to about

11% sulphuric acid, depending upon the temperature of the bath, the thickness of the coat, the rate of drawing, etc.

As known in the art, other coagulants and other acids may be employed in lieu of ammonium sulphate and sulphuric acid.

Referring to Fig. 10, the relation of the mandrel-section 3 to the forming-ring J and the coating-ring K is important. Thus, the mandrel-section 3 is reduced to provide clearance 3^a between the mandrel and the paper tube G, except that bearing flanges 3^b, 3^c, and 3^d are left on the exterior of the mandrel. The flange 3^b is slightly above the forming-ring J; the flange 3^c is slightly above the coating-applying ring K; and the flange 3^d (a wider flange) underlies the annular orifice 38. The purpose is to avoid binding action on the paper tube and prevent opening the seam. Preferably, it will be noted, the clearance 3^a extends through the forming-ring, so that while pressure is applied to the exterior side of the seam, no binding against the mandrel will occur. In other words the tautness of the paper will suffice, as opposed to the forming-ring pressure.

In a modification illustrated in Fig. 12, provision is made for applying an internal coating to the paper tube, designated G², after it has been formed and its longitudinal margins have been pasted together. In this case the mandrel, designated H', is of modified form. It has an enlarged tubular portion 39, the lower end of which supports an internal coating-applying device, designated K². This device is provided with an outwardly directed annular orifice 40 through which viscose is applied to the inner surface of the paper tube. A downward extension of the mandrel from the device K² is in the form of a tubular member 41 which supports a spreader 42 which serves to even or make more uniform the internal coating. If desired, an external ring 43 may be opposed to the internal coating-applying device K².

An internal bath may be supplied through a descending pipe 44 and a return pipe 45, corresponding with the pipes 9 and 10 shown in Fig. 11. Thus, the internally coated tube may be subjected to the action of an internal bath as well as an external bath. If desired, both internal and external coatings of a cellulose derivative may be applied to the paper tube. In the reaction which occurs during the passage of the tube through the bath, the viscose paste in the seam is also coagulated and regenerated. Thus, the tube becomes virtually an integral tube, the joint being effectively sealed by the regenerated cellulose.

In the modification shown in Fig. 12, viscose is supplied to the coating-applying device K² through an internal pipe 46.

In the modification shown in Fig. 13, the paper strip and the tube formed therefrom are designated G³. In this case, a coating of viscose is applied to one surface of the strip at the point L, and the coated strip then passes through a drier M, thence about a roller N, and thence downwardly about a mandrel similar to the mandrel H heretofore described. A spray of solvent for the viscose is applied at O to the underlying margin of the strip to soften the viscose. The tubular strip then passes through a forming ring J' where the pasting is effected, and thence through a coating device K³, if desired. At this point, a very thin second coating of viscose may be applied, if desired. The coated tube then passes downwardly through the bath B' heretofore

described, and the tube then passes through the subsequent baths in the manner already described.

In the modification shown in Fig. 14, the paper strip and tube are designated G⁴. In this case, a viscose coating is applied and the paper is formed into tubular form while the viscose is still wet. The viscose coating is applied at L', the coated strip then passes about a roller N', thence downwardly about the mandrel and through a forming-ring J², and thence through a smoothing-ring Q, where the coating is rendered more uniform and where additional viscose may be applied, if desired. The tube then continues downwardly through the bath B', and thence through the subsequent baths, as described above in connection with the preferred procedure.

If desired, the previously described coating-applying device K may have substituted therefor the coating-applying device Q.

It is preferred, in the manufacture of a coated tube which will have an extensive use in providing containers for meats, large diameter sausage-compositions, fruits, etc., to employ a very thin paper produced from long fibres. Papers well known on the market, such as Japanese papers known as yoshino paper, rice paper, and the like, are well adapted to the purpose. The papers which it is preferred to use are extremely attenuated and porous, however, being commonly of a thickness varying perhaps from .001 to .0025. While it is not desired to limit the invention unnecessarily, it may be said that these very thin papers can be employed in the improved process and produce very desirable tough, strong regenerated-viscose-coated tubes well adapted for use in situations requiring much strength, coupled with semi-transparency, or translucency.

It will be understood, however, that since the tubing must be drawn at great length through the coagulating and regenerating bath, thence through the subsequent baths, and finally through a drier, if it be desired to include the latter step in the continuous process, it is essential that precautions be taken to prevent injury to the paper. The manner in which the paper is led from the roll G' in Fig. 1 and gradually brought into tubular form in practically free condition in descending to the mandrel contributes to the success of the process. The application of the viscose coating to the paper tubing some distance above the bath B' gives time for permeation and the forming of a matrix to occur and permits a certain tempering of the coated tubing before the tube enters the coagulating and regenerating bath. This is believed to contribute to the successful drawing of the tubing through the baths. When the coated tubing enters the bath B', the coagulation occurs almost instantly, and the regeneration proceeds fairly rapidly and is to a substantial extent accomplished before the paper passes about the roll B² in the bottom of the bath B'. As indicated above, any internal gases developed during the passage of the tube through the bath B' will be exhausted through the suction pipe 10.

A suitable so-called viscose solution, adapted for use in the process, may be prepared in accordance with procedures now well known in the art. Various cellulose derivatives known in the art may be employed in lieu of viscose. Cellulose derivatives include such derivatives as are produced by the cuprammonium process, and

other cellulose esters, such as cellulose acetate, mineral esters, such as cellulose nitrate, and ethers, such as ethyl-cellulose. Viscose may be otherwise defined as an aqueous dispersion of cellulose-sodium xanthate and cellulose.

As is known, cellulose ethers may be held in solution or dispersion in various solvents; some in organic solvents, and some in aqueous solvents, or in aqueous alkali solutions. A suitable solution of cellulose ether may be used in the practice of the improved process, in lieu of a cellulose ester solution, if desired. Thorough impregnation of the fabric may be accomplished by methods described in the present specification with reference to the application of viscose solutions; and the cellulose ether may be precipitated during passage of the impregnated fabric tube through the bath B'. For example, if an aqueous alkali solution of cellulose ether (known in the art) be employed, the alkali will be neutralized by the acid in the bath and the cellulose ether will be precipitated in and on the fabric of the tube. Where, as in the case of cellulose ethers, simple precipitation will suffice, it may be desirable to employ in the precipitation bath the higher acidity mentioned above.

Of course, where cellulose derivatives, such as cellulose esters other than viscose are used in the process, suitable regenerating agents are to be employed in converting the coating to cellulose or cellulose hydrate. For example, cellulose acetate may be employed, and may be de-esterified in any suitable known manner. For example, this ester may be hydrolyzed in any known manner.

The improved process enables regenerated-cellulose-coated fabric tubes composed of suitable vegetable fibres to be produced in an economical manner. It is of especial importance that the invention enables regenerated-cellulose-coated tubes to be produced by a continuous process which can be practiced economically on a large scale with facility. By providing the tube-drawing apparatus with a battery of mandrels, forming devices, coating appliances, and means for handling a plurality of tubes, a single attendant may take care of one or more machines having a capacity for large production.

It should be stated that the mandrel H, or the bearing surfaces thereof, which are opposed to the inner wall of the paper tube, preferably becomes, or become, of slightly less diameter as the lower portion of the mandrel is approached. For example, the bearing-flanges 5^a may be reduced very slightly in diameter, progressively, in a downward direction; and as appears from Fig. 11, it is desirable to have a substantial clearance between the mandrel and the inner wall of the tube during the passage through the bath B'. In this portion of the course of the tube, the internal head of pressure furnished by the bath 7 is opposed to the external head of pressure exerted by the external bath B'. In fact, the level of the internal bath preferably is slightly above that of the external bath, so that danger of collapsing of the tube is obviated.

As has been indicated above, when a cellulose derivative coating is applied to a paper tube, the coating permeates the paper and tends to form a matrix which more strongly mats together the fibres of the paper. This is notably true where a viscose coating is applied. So far as certain phases of the invention are concerned, it would be within the scope of the invention to manufacture the paper from a suitable paper pulp admixed with a cellulose derivative, such as viscose,

dry the paper, and then subject it to the tube-forming and regenerating operations. The use of a very substantial amount of cellulose derivative is contemplated. It has been found highly satisfactory, for example, to apply, in the first described process, the coating material in such quantity that the paper tube bearing the regenerated cellulose possesses a weight, after drying, which is on the order of three times the weight of the paper employed in the process.

Where the cellulose derivative employed is, for example, cellulose acetate, it is advisable to dry the paper after the cellulose acetate has been applied, and then pass the paper, after the tube has been formed, through a bath which will effect the regeneration, such as a suitable alkali bath. The operations of subjecting the tube, coated or permeated with cellulose acetate, to regeneration and subsequent purification, may be similar to the methods already described in connection with the preferred process.

While it is preferred to pass the coated or permeated paper tube through a bath contained in a suitable tank, it will be appreciated by those skilled in the art that it may be expedient, in some cases, to apply the regenerating medium, or the coagulating and regenerating media, in other suitable ways, such as by spraying operations. In the case of viscose, it is known, of course, that regeneration can be effected by applying heat, and such method may be resorted to for certain purposes, if desired.

The improved process provides, in effect, an integral regenerated cellulose tube reinforced by paper fibre, it being noted that the regenerated cellulose not only fills all meshes and pores in the paper but also forms a continuous film or coating on the surface of the paper. Thorough permeation of the paper will, of course, result in a coating, or coatings, on the paper tube.

The foregoing detailed description is given for clearness of understanding only, and no unnecessary limitations should be understood therefrom, but the appended claims should be construed as broadly as permissible in view of the prior art.

What I regard as new and desire to secure by Letters Patent is:

1. Apparatus for forming coated tubes comprising: a precipitating bath tank; a tubular mandrel depending into said tank; tube-forming means associated with said mandrel; and means for drawing a strip of fabric downwardly between said mandrel and said tube-forming means and passing the tube progressively, as formed, through a precipitating bath in said tank, the tube having thereon a cellulose-derivative-coating which is subjected to precipitating action in passing through said bath.

2. Apparatus as specified in claim 1, combined with means for progressively applying a cellulose-derivative-coating to the formed tube as it passes to said bath.

3. Apparatus for forming cellulose-derivative-coated tubes, comprising: a precipitating bath tank; a tubular mandrel suspended above said tank and depending thereinto; means for supporting a fabric strip and shaping it into tubular form with overlapping longitudinal margins about said mandrel; means for effecting pasting together of said margins as the tubular strip passes to the bath; and means for drawing the formed tube downwardly about said mandrel into a precipitating bath in said tank.

4. Apparatus as specified in claim 3, in which

said tank is provided at its lower portion with a guide about which said tube is drawn in flattened condition.

5. Apparatus as specified in claim 3, combined with a guide in the lower portion of said tank about which said tube is drawn in flattened condition, and combined also with means extending through said mandrel for maintaining an internal liquid head in said tube above said guide.

6. Apparatus as specified in claim 3, in which the drawing means includes a guide roll for directing said tube upwardly out of the precipitating bath.

7. Apparatus as specified in claim 3, supplemented by a purifying bath and a guide roll for directing the tube upwardly out of the precipitating bath and guide-means for feeding it through the purifying bath.

8. Apparatus as specified in claim 3, combined with means for applying a cellulose derivative coating externally to the formed tube during its passage to the precipitating bath.

9. Apparatus as specified in claim 3, combined with means for applying a cellulose derivative coating internally to the formed tube during its passage to the precipitating bath.

10. Apparatus for manufacturing regenerated-cellulose-coated tubes comprising: a regenerating bath tank; a mandrel supported above said tank and depending thereinto; a transverse guide associated with the lower end of said mandrel about which the tube may be passed in flattened condition; means for supporting a fabric strip and forming it in tubular form about said mandrel as the strip moves toward said tank; means associated with said mandrel for pasting together the longitudinal margins of said strip progressively; a coating-applying device having an annular orifice presented to a surface of the formed tube; and means for feeding a cellulose derivative in measured quantity through said coating-applying device.

11. In apparatus of the character set forth: a precipitating bath tank; a mandrel supported at a distance above said tank and depending thereinto; means for supporting a fabric strip at a point above the mandrel; a forming-ring encircling the mandrel at a distance above the bath; a seam-paste-applying device above said forming-ring; a coating-applying device below said forming-ring for applying a cellulose derivative to the formed tube; a transverse guide in the lower portion of said tank; and means for drawing the formed tube in flattened condition about said guide and upwardly out of said tank.

12. Apparatus as specified in claim 11, combined with a purifying bath tank and means for feeding the tube therethrough subsequent to its emergence from the precipitating bath.

13. Apparatus as specified in claim 11, in which the seam-paste applying device comprises a nozzle and an associated guide-member carried by the mandrel.

14. Apparatus as specified in claim 11, in which the seam-paste applying device comprises a nozzle and a fixedly supported member opposed thereto having a surface for supporting the underlying margin of the strip and having another surface for guiding the overlying margin of the strip and keeping said margins separated until they have passed the nozzle.

15. Apparatus as specified in claim 11, in which the seam-paste applying device comprises a fixed guide-plate associated with the mandrel and an opposed adjustably mounted nozzle through which the paste passes.

16. Apparatus for manufacturing regenerated-cellulose-coated tubes, comprising: a regenerating bath tank; a tubular mandrel supported above said tank and depending thereinto; means for supporting a fabric strip and permitting it to descend into position about said mandrel; means associated with the mandrel for forming said strip into a tube and applying a cellulose derivative coating to said tube as the tube approaches the bath; a guide in the lower portion of said tank about which the tube may pass in flattened condition; means depending through said mandrel for maintaining an internal bath of predetermined head within the tube above said guide; and means for progressively feeding the tube and drawing the strip over the mandrel.

17. Apparatus as specified in claim 16, in which said mandrel has its lower end equipped with a depending member serving to gradually flatten the tube as it approaches said guide.

18. Apparatus for the manufacture of regenerated-cellulose-coated tubes comprising: a regenerating tank; a mandrel depending thereinto; means associated with said mandrel for forming a tube with overlapped longitudinal margins from a fabric strip drawn longitudinally over the mandrel; means for applying a cellulose derivative coating to said strip before it is formed into a tube; and means for drawing the tube downwardly about said mandrel into the regenerating bath tank.

19. Apparatus as specified in claim 18, combined with means for drying the coating applied to said strip before said strip reaches the mandrel.

20. Apparatus for forming reinforced seamless-matrix tubes, comprising: a precipitating bath, a mandrel depending into said bath; and means for feeding progressively downwardly over said mandrel and through said precipitating bath a paper tube thoroughly impregnated and coated with a solution of a cellulose derivative.

21. Apparatus for forming reinforced seamless-matrix tubes, comprising: a precipitating bath; means for progressively forming a fabric strip into a tube and impregnating and coating the tube with a cellulose derivative solution; and means for progressively feeding the impregnated and coated tube through said precipitating bath.

22. Apparatus for making impregnated tubes, comprising: a precipitating bath tank; a purifying bath tank; means for forming into tubing a cellulose-derivative-impregnated fabric strip; and means for feeding said tubing progressively through precipitating and purifying baths in said tanks.

23. Apparatus as specified in claim 22, in which the forming means progressively curls a flat fabric strip into tubular form as said strip approaches the precipitating bath.

24. Apparatus as specified in claim 22, in which the forming means progressively curls a flat fabric strip into tubular form as said strip approaches the precipitating bath, and means is provided to coat the one face of the tubing progressively as it advances to said bath.

JOHN PAUL SMITH.