

May 5, 1931.

M. O. SCHUR

1,803,409

MANUFACTURE OF IMPREGNATED FIBER ARTICLES

Filed July 30, 1929

2 Sheets-Sheet 1

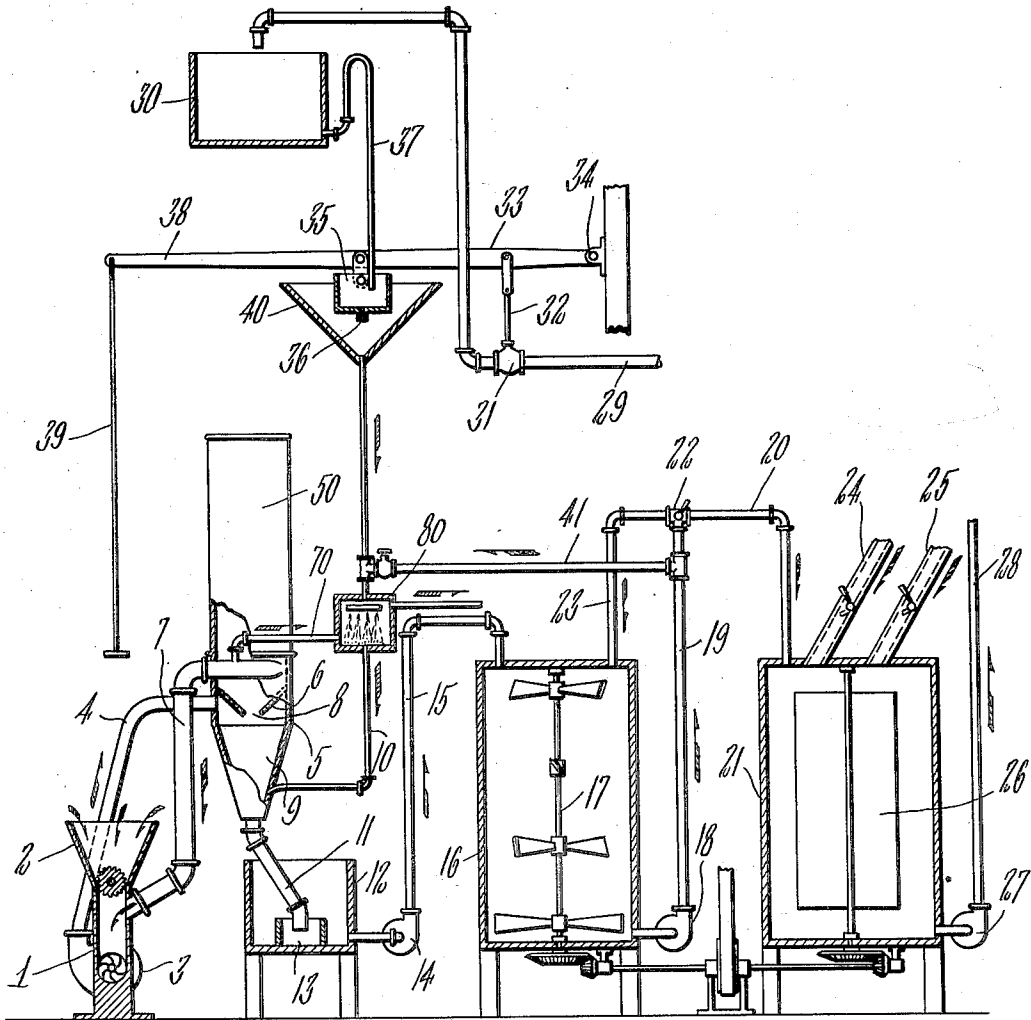


Fig. 1.

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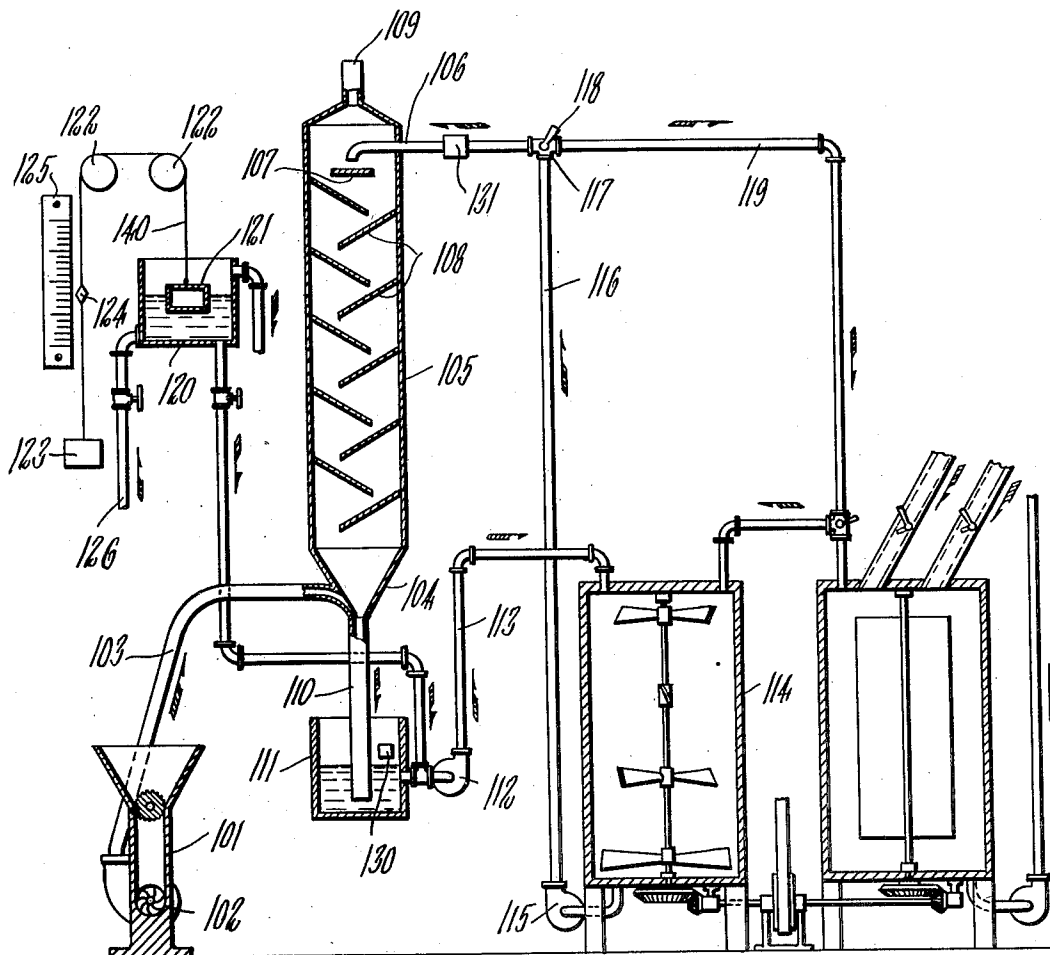


Fig. 2.

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UNITED STATES PATENT OFFICE

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MANUFACTURE OF IMPREGNATED FIBER ARTICLES

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This invention relates to the manufacture of impregnated fiber articles, being more particularly concerned with a method of manufacture comprising the step of first forming an article of the desired shape from cellulose pulp, drying, and then impregnating with an agent which imparts desired characteristics such as water-resistance thereto. Various problems may arise in such a method, the seriousness of which depends upon the raw materials used, the finished article to be manufactured, and the conditions under which the various steps are practiced. One problem is forming the pulp into an article which may be subsequently dried and impregnated in a satisfactory and expeditious manner. This problem has been baffling in the case of comparatively thick-walled fiber tubes made by winding a wet web of interfelted cellulose pulp into tubular form, as on a mandrel, then drying and finally impregnating with waterproofing material such as molten pitch, as in such case difficulties are experienced when either free or slow pulp is employed as a raw material. When the pulp is free and contains comparatively little gelatinized cellulose, porous tubes which readily undergo impregnation result, but drying of such tubes must be carried out slowly and under carefully controlled conditions of temperature and humidity in order to avoid splitting or separation between the matted together laminae of which the tube walls are made. When the pulp is slow and contains considerable gelatinized cellulose, although liability to split is lessened, not only are the resulting tubes dense and difficult to impregnate, but they must be dried slowly in order to avoid warping. There is only a narrow range of hydration or gelatinization of pulp from which may be made tubes, the laminae of which are well bonded together, which may be rapidly dried without splitting or warping, and which may be impregnated at a satisfactory rate and at temperatures at which charring or embrittlement of the fiber walls it not effected. The amplitude and position of the range for optimum results varies considerably, depending upon the stock or beater furnish employed. As a re-

sult of these variations, when for instance a preferred stock composed of ground wood pulp and chemical wood pulp screenings is employed, it is only through the exercise of considerable care in grinding, beating, drying, and impregnating that satisfactory results are obtainable. Comparatively slight changes, for example in the nature of the screenings, brought about perhaps by a change in cooking procedure or screening practice in the pulp mill, have caused much trouble in tube manufacture, necessitating in some instances extensive changes in such factors as grinding, beater manipulation, and rates of drying and impregnation. Even under careful testing and supervision, incompletely impregnated tubes are likely to escape detection and be shipped out of the mill.

I have discovered that if materials such as ground charcoal or coke, kieselguhr, or asbestos flour are incorporated into the pulp, the range of hydration within which articles made from the pulp are capable of being dried and impregnated in a satisfactory and expeditious manner, is greatly increased. While not limited thereto, my discovery will now be disclosed in greater detail as applied to the manufacture of tubes of the character hereinbefore described. I have further found that if materials such as hereinbefore enumerated are incorporated into the pulp from which the tubes are made, remarkable and important improvements are effected in the impregnated tubes. Powdered charcoal which may be prepared from charcoal fines or screenings is the preferred material, not only because it is cheap and makes possible economies in manufacture, but because it effects most marked improvements. It is superior to the cheaper powdered coke breeze, which, however, is heavier and more liable to settle out in the pulp vat in which rotates the cylinder mold on which the web used for winding the tubes is formed. Moreover, powdered coke may contain particles having abrasive-like characteristics, which would dull tools such as are employed in finishing the ends of the tubes for joining, and may further contain graphitic material which would impair the dielectric strength of the

tubes, this being undesirable, as a major use for such tubes is housing electric cables or the like.

Another phase of my invention relates to the grinding and handling of solid materials, such as charcoal, which are to be incorporated into the pulp. After grinding, the material may be uniformly suspended in water and mixed in this form with the pulp. Particularly when charcoal is the material being ground, it should be kept from the atmosphere in order to avoid dust nuisance and fire and explosion hazard. To this end, my method involves grinding the material and suspending it in water while it is under confinement, this preferably being accomplished by blowing the ground material while maintained under confinement in contact with a countercurrent flowing stream of water to form an aqueous suspension of charcoal. The water used for forming the suspension is preferably that removed from the cylinder mold during the formation of the web, as this avoids a loss of ground material and fiber passing through the openings of the cylinder mold. The charcoal may be ground to various degrees of fineness, it ordinarily being preferable to use charcoal ground to about thirty to, say, 150-mesh fineness, as in this condition it may be easily handled without dust nuisance, and does not produce rough tube surfaces.

On the accompanying drawings is illustrated somewhat diagrammatically and conventionally apparatus for preparing the charcoal or other material in the form of an aqueous suspension and then mixing with stock prior to use.

Figure 1 shows one form of apparatus which may be used for this purpose.

Figure 2 shows a preferred form of apparatus.

Referring to Figure 1 of the drawing, 1 represents as a whole a grinder provided with a hopper 2 into which charcoal in weighed quantities may be delivered for grinding. The ground charcoal passes into a blower 3 by means of which it is blown through a conduit 4 preferably tangentially into a vertical cylindrical receiver 5, which may be provided at its upper end with a cloth bag designed to permit the escape of air but to retain the charcoal, and at its lower end with a hopper 9. Inasmuch as a cloth bag may be more or less troublesome because of its tendency to clog and to permit the escape of very fine dust when cleaned, it is preferred to place a tight-fitting drum or cover 50, as shown, over the receiver 5, air being permitted to escape through a vent pipe located in the drum or as hereinafter described. The air escaping through the vent pipe may be washed with water or charcoal suspension for the recovery of charcoal particles. Within the receiver 5, there is preferably provided a conical-shaped

partition 6 extending downwardly from its walls and having an opening 8 at its lower end, a cyclone effect being produced as the air and charcoal impinges against the partition, the charcoal particles tending to separate out from suspension in air on the wall of the receiver while air comparatively free from charcoal particles rises into the cloth bag or drum 50. In order to minimize the amount of air to be discharged through the bag or from the drum 50 into the atmosphere, a portion of the air may be withdrawn from the bag or drum 50 into the blower 3 through a conduit 7. When a cloth bag is used, it is thus necessary to provide a bag of a size designed to discharge only the air coming into the blower 3 along with the charcoal through the hopper 2. The charcoal separating out in the receiver comes in contact with a stream of water or charcoal suspension being delivered thereinto from a water pipe 10 to produce a suspension of charcoal in water. As shown on the drawing, the conduit 7 may be provided with a vent pipe 70 leading to a comparatively small tower 80, where the excess air is washed with the water or charcoal suspension from the pipe 10, the effluent from the tower then being delivered into the receiver. The suspension passes down the hopper 9 through a pipe 11 and into a tank 12, a water seal 13 preferably being provided at the point of discharge into the tank so that no air from the receiver may escape along with the suspension. The suspension is removed from the tank 12 by a pump 14 which passes it through a pipe 15 into a storage tank 16 from which it may be removed as needed for mixing into stock to be used in tube manufacture. Preferably the tank 16 is provided with suitable agitating means, such as a paddle agitator 17, so that a uniform suspension of charcoal may be produced and maintained. The suspension may be withdrawn from the tank 16 by a pump 18 and delivered through pipes 19 and 20 into a tank 21 where mixing with stock of the desired quantity may be effected. Preferably the pipe 19 terminates in a tee fitting 22 which is provided with a valve permitting the suspension to be passed through the pipe 20 into the tank 21 or returned through a pipe 23 into the tank 16. A circulation of the suspension may thus be afforded from the bottom to the top of the tank 16 to facilitate the production and maintenance of a uniform suspension. Along with the charcoal fed into the tank 21 may be delivered stock of the desired type, one sluice 24 communicating with this tank being for beaten screenings, and another sluice 25 communicating with this tank being for ground wood pulp or beaten old newspapers, for example. The various components in this tank may be mixed as by means of a cylinder agitator 26 which is effective for such mixing. The mixed stock may be removed from the

tank 21 by a pump 27 and passed through a pipe 28 into the vat (not shown) in which rotates the cylinder mold on which the pulp web is formed.

In order that the concentration of the charcoal suspension in the storage tank 16 may be known within close limits at all times, a given quantity of white water being removed from the cylinder mold may be delivered to the charcoal system. White water may be passed through a pipe 29 into a storage box 30 above the receiver 5, the flow of white water taking place through a quick-acting valve 31, the opening and closing of which is controlled by a rod 32 fixed to a lever 33 pivoted as at 34. The lever 33 is shown carrying a box 35 provided with an opening 36 at its bottom, white water flowing thereinto by gravity through a pipe 37 communicating with the box 30 near its bottom and which takes the form of an inverted U outside of the box, the base of the U being below the top of the box. When water in the box 30 rises above the base of the U, siphon action results in a flow of water from the box 30 to the box 35. The valve 31 may be opened to permit the flow of water with the box 30 by raising the free end 38 of the lever 33, a handle 39 extending downwardly so that an operator may push up thereon to accomplish this result. When the valve 31 is thus opened, water runs into the box 30 until the siphon action has commenced, whereupon the water delivered into the box 35 by its weight closes the valve 31 through the motion of the lever 33 on which the box 35 is carried. Siphon action ceases when substantially all the water in the box 30 has been discharged into the box 35 from which it flows downwardly through the aperture 36 into a funnel 40 discharging by gravity into the pipe 10 communicating with the hopper 9. A single push on the rod 39 by the operator thus suffices to add a definite measure of water to the charcoal system without further attention. In order to increase the flow of wash water through the hopper thereby permitting greater convenience in operating the system and ensuring complete wetting of the charcoal powder, a portion of the suspension may be withdrawn from the tank 16 by a pump 18 through the pipe 19 and a pipe 41 communicating with the pipe 10, white water being passed into the pipe 10 from the box 30 as needed. Such a system has the advantage that although the charcoal is being ground rapidly and efficiently in a comparatively small mill, it may be stored in large quantities at a definite concentration in water ready for use at all times.

A more simple and effective procedure of producing a charcoal suspension may be practiced by means of the apparatus shown in Figure 2. This procedure involves blowing the air and charcoal delivered from the

grinder directly into a tower in which the charcoal may be washed from the air by water or charcoal suspension. Such a procedure renders unnecessary a centrifugal separation of the charcoal particles from the air. Inasmuch as only fresh air need be introduced into the grinder, there is no danger such as is present in the apparatus of Figure 1, of carrying a fine mist of water along with air being returned to the grinder, thereby moistening the charcoal, which in moist condition tends to cake and plug the grinder. Referring to Figure 2 of the drawings, 101 represents a grinder into which charcoal may be delivered and from which the ground material passes into a blower 102 along with fresh air being drawn into the grinder. The charcoal powder is blown through the conduit 103 into the lower funnel-shaped end 104 of a tower or scrubber 105, which may be supplied near its upper end from a pipe 106 with a stream of water or charcoal suspension, the stream impinging against a distributor plate 107 shown located centrally of the tower. The tower is preferably provided throughout its length with a series of downwardly sloping baffles 108, which extend alternately from opposite walls of the tower and overlap one another, these baffles ensuring the thorough contact of the water with the powdered charcoal which is suspended in the water as the water gravitates from baffle to baffle. The washed air rising to the top of the tower may be allowed to escape into the atmosphere as through a vent pipe 109. The charcoal suspension passes from the funnel-shaped lower end of the tower through a pipe 110 discharging into a tank 111 in which a pool of suspension is maintained sufficiently above the lower end of the pipe 110 to serve as a seal to the tower. The suspension in the tank 111 may be withdrawn by a pump 112 and delivered through a pipe 113 into a mixing tank 114. The suspension may be withdrawn from the tank 114 by a pump 115 and passed through a pipe 116 terminating in a T fitting 117 provided with a valve 118 permitting the suspension to be passed through a pipe 106 for circulation through the tower 105 or through a pipe 119 for admixture with pulp. The water for producing the suspension may be drawn from a box 120 preferably provided with a float member 121 to which may be attached one end of a cord 140 passing over a pair of rollers 122 and terminating sufficiently below the rollers 122 so that a substantial stretch may be maintained vertical by a suitable weight 123 provided at its other end. A suitable indication 124 may be carried by the vertical stretch of the cord in co-operative relationship with a scale 125, the graduations of which may be calibrated in terms of the water content of the box 120 at different levels of the indicator 124 which

rises and falls with the level of the water in the box. For a given charge of charcoal being ground, the desired amount of water may be introduced into the box 120 from a water supply pipe 126, whereupon the water may be discharged from the box into a suitable point in the system, for instance, as shown into the intake end of the pump 112 serving to pass suspension from the tank 111 to the mixing tank 114. In order to minimize the chances for difficulty in operating the system, suitable control mechanism 130 may be provided in the tank 111 to shut off the motor driving the pump 112 if the level of suspension in the tank 111 becomes too high. So, too, suitable control mechanism 131 may be provided in the pipe 106 to shut off the motor driving the grinder 101, should the water supply to the tower be cut off. The system hereinbefore described permits the production of a charcoal suspension of substantially constant concentration in the tank 114, from which the suspension may be withdrawn and mixed on an accurate volumetric basis with pulp.

The charcoal in suspension may be added in various proportions by weight to the fibrous stock, improvements being noted when even as low as two to three per cent. is added. Below are tabulated runs with characteristic results obtained with and without the use of charcoal:—

Per cent charcoal in tube	0	15.0	25.0
Per cent screenings in tube	45.0	38.2	33.7
Per cent ground wood in tube	55.0	46.8	41.3
Dia. of mandrel (in.)	3 $\frac{3}{4}$	3 $\frac{3}{4}$	3 $\frac{3}{4}$
Outside dia. of wet tube (in.)	5 $\frac{1}{4}$ ₆	4 $\frac{7}{8}$	4 $\frac{1}{2}$ ₃ ₄
Thickness of dry tube wall (in.)	0.300	0.307	0.323
Shrinkage of tube length (per cent)	6.77	6.77	6.77
Weight per ft. of dry tube (lbs.)	0.800	0.710	0.735
Porosity towards Air (arbitrary)	36	89	123
Ratio of pitch to pulp and charcoal (3 hrs. impregnation at 306° F. and under 76 lbs./sq. in.)	1.01	1.67	1.77
Weight per ft. of length at wall thickness of 0.300 in.:			
In lbs. of pulp	0.800	0.590	0.512
In lbs. of charcoal	0	0.104	0.171
In lbs. of pitch (tube fully impregnated)	1.09	1.16	1.21
Time required for complete impregnation	12-14 hrs.	Less than 3 hrs.	Less than 3 hrs.
Breaking strength:			
Unimpregnated tube	862	665	620
Tube impregnated for 3 hrs.	1,530	1,565	1,315
Impact resistance:			
Unimpregnated tube	9.6	6.4	6.8
Tube impregnated for 3 hrs.	10.4	13.6	13.8
Crushing strength:			
Unimpregnated tube	315	285	259
Tube impregnated for 3 hrs.	415	456	427
Water absorption in 48 hrs. (per cent):			
Tube impregnated for 3 hrs.	10.2	3.6	3.6
Dielectric strength (volts):			
Tube impregnated for 3 hrs. and soaked in water for 48 hrs.	22,500	24,000	27,000

From the foregoing table, it is seen that the presence of charcoal in the stock modifies the characteristics of the tube during drying,

the shrinkage in wall thickness being considerably lessened. Although the shrinkage in length is constant in the foregoing table other runs show a very slight increase when charcoal is used. The net result is a tube wall of less density, weighing for the same diameter of tube and wall thickness less per unit length, and absorbing during impregnation more pitch and in a much shorter period of time. The pitch-impregnated tube is less brittle, having higher impact and crushing strengths. Its breaking strength may be lowered slightly depending upon the quantity of charcoal used, but this may be sufficiently compensated for through the use of harder pitch, and is of no great moment. The rate of absorption of water by the tube impregnated 3 hours is lowered and its dielectric strength after soaking in water is raised.

The cost of manufacture of the finished tube is materially reduced by the use of charcoal, as both the charcoal and the additionally absorbed pitch take the place of the more expensive pulp. Moreover dryer production may be greatly increased and maintained, there being less water to be removed from the tube in the drying apparatus. Impregnation with pitch may be greatly hastened, thereby reducing the consumption of steam and power. Rejections caused by poor drying and impregnation are practically eliminated, as is also the danger that incompletely impregnated tubes may escape detection and be sent out into the field where because of their imperfect resistance against water they may cause serious trouble. The explanation of the improvement effected by the use of a material such as charcoal is thought to be somewhat as follows. Because of its honey-comb structure, charcoal furnishes channels or pores in the wet tubes which remain substantially of constant size throughout the drying operation, giving moisture free passage by diffusion from the inner portions of the tube wall to the surfaces where evaporation takes place. The charcoal particles by remaining of substantially constant dimensions during drying probably oppose the shrinkage of one lamina of a tube wall against the next, reducing the density of the dried tube and thus increasing the porosity of the tube. During subsequent impregnation, the pores or channels thus left in the tube permit the pitch to penetrate the wall more easily. During the drying operation, the charcoal probably absorbs soluble and colloidal matter which is normally present in the stock, preventing the diffusion of such matter to the surfaces of the tube wall and thus avoids the formation of clogged pores in the outer layers which ordinarily would interfere with easy penetration of the pitch into the tube wall. Again, it is probable that the bonding between the charcoal particles and the fibers lying adjacent

thereto is very poor, so that when the tube is dried, pores are formed immediately about the charcoal particles.

A further important advantage which may be realized by the use of charcoal is that it is possible to employ types of raw materials which could not heretofore be employed satisfactorily. Thus it has been found that when charcoal is used in the stock, old newspapers may be used in lieu of the ground wood heretofore used and a great saving in the cost of manufacture realized. Without the presence of charcoal, a large proportion of tubes made out of stock containing old newspapers are likely to split and undergo deformation during drying, whereas by the use of charcoal it is possible to produce satisfactory tubes consistently.

Owing to the lack of a generic term of materials, such as ground charcoal or coke, kieselguhr and asbestos flour, I shall define these materials generically in terms of a common function which they perform. All these materials are characterized by the fact that they increase the porosity of fiber articles, such as tubes, through which they are distributed, so that by the term "pore-forming agent", as used in the claims, I mean these materials or their equivalent, irrespective of whether the porosity of the material itself and/or secondary effects cause the increase in porosity. These materials may be further described as solids which are infusible, that is, which do not tend to fuse or melt during high-temperature drying of the pulp articles through which they are incorporated and accordingly which do not tend to decrease porosity by flowing into the pores of the articles. While I have dealt specifically with the use of pitch as an agent for impregnating fiber articles, such as tubes, it should be understood that other agents both of thermoplastic variety, such as Montan wax and paraffin, or liquid agents, such as oil, might be used, depending on the characteristics which it is desired to impart to the finished articles.

I claim:

1. An impregnated article comprising cellulose fiber, a solid, infusible pore-forming agent and the impregnating agent.

2. An impregnated article comprising cellulose fiber, a finely divided solid, and infusible pore-forming agent and the impregnating agent.

3. A step-product consisting of a comparatively thick-walled, cellulose fiber article containing a solid, infusible pore-forming agent distributed therethrough, the wall of said article being penetrable with relative ease and uniformity by an impregnating agent.

4. A step-product consisting of a comparatively thick-walled cellulose fiber article containing finely divided charcoal distributed therethrough, the wall of said article be-

ing penetrable with relative ease and uniformity by an impregnating agent.

5. A step-product consisting of a tube made up of laminae of interfelted cellulose fiber containing finely divided charcoal.

6. An impregnated article comprising cellulose fiber, charcoal, and the impregnating agent.

7. A tube, the wall of which is composed of interfelted cellulose fiber containing a solid, infusible pore-forming agent and impregnated with waterproofing material.

8. A tube, the wall of which is composed of matted-together laminae of interfelted cellulose fiber containing finely divided charcoal and impregnated with pitch.

9. A process which comprises distributing a solid, infusible pore-forming agent throughout a fibrous article, and then impregnating the article with the desired agent.

10. A method of incorporating solid material into pulp which comprises grinding the material and suspending it in water while maintained under confinement, and mixing the suspension with the pulp.

11. A method of incorporating solid material into pulp which comprises grinding the material, blowing the ground material while maintained under confinement into contact with water to form an aqueous suspension of such material, and mixing the suspension with the pulp.

12. A method of incorporating solid material into pulp which comprises grinding the material, blowing the ground material while maintained under confinement in contact with a countercurrent flowing stream of water to form an aqueous suspension of such material, and mixing the suspension with the pulp.

13. In the manufacture of impregnated cellulose fiber articles, those steps which comprise incorporating a solid, infusible pore-forming agent into cellulose pulp, forming the pulp into an article of the desired shape, drying, and impregnating with the desired agent.

14. In the manufacture of impregnated cellulose fiber articles, those steps which comprise incorporating charcoal into cellulose pulp, forming the pulp into an article of the desired shape, drying, and impregnating with the desired agent.

15. In the manufacture of impregnated cellulose fiber tubes, those steps which comprise incorporating charcoal into cellulose pulp, forming an interfelted web of the pulp, winding the web into tubular form, drying, and impregnating with pitch.

16. A method which comprises forming an aqueous suspension of powdered charcoal, mixing the suspension with cellulose pulp, forming into an article of the desired shape, drying, and impregnating with the desired agent.

17. A method which comprises forming an aqueous suspension of ground charcoal, mixing the suspension with cellulose pulp while it is being beaten, forming the mixture into an interfelted web, winding the web into a comparatively thick-walled tube, and impregnating the tube with pitch.

In testimony whereof I have affixed my signature.

MILTON O. SCHUR.

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