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2,369,488

METHOD OF MAKING HOLLOW ARTICLES

Filed Aug. 14, 1940

2 Sheets-Sheet 1

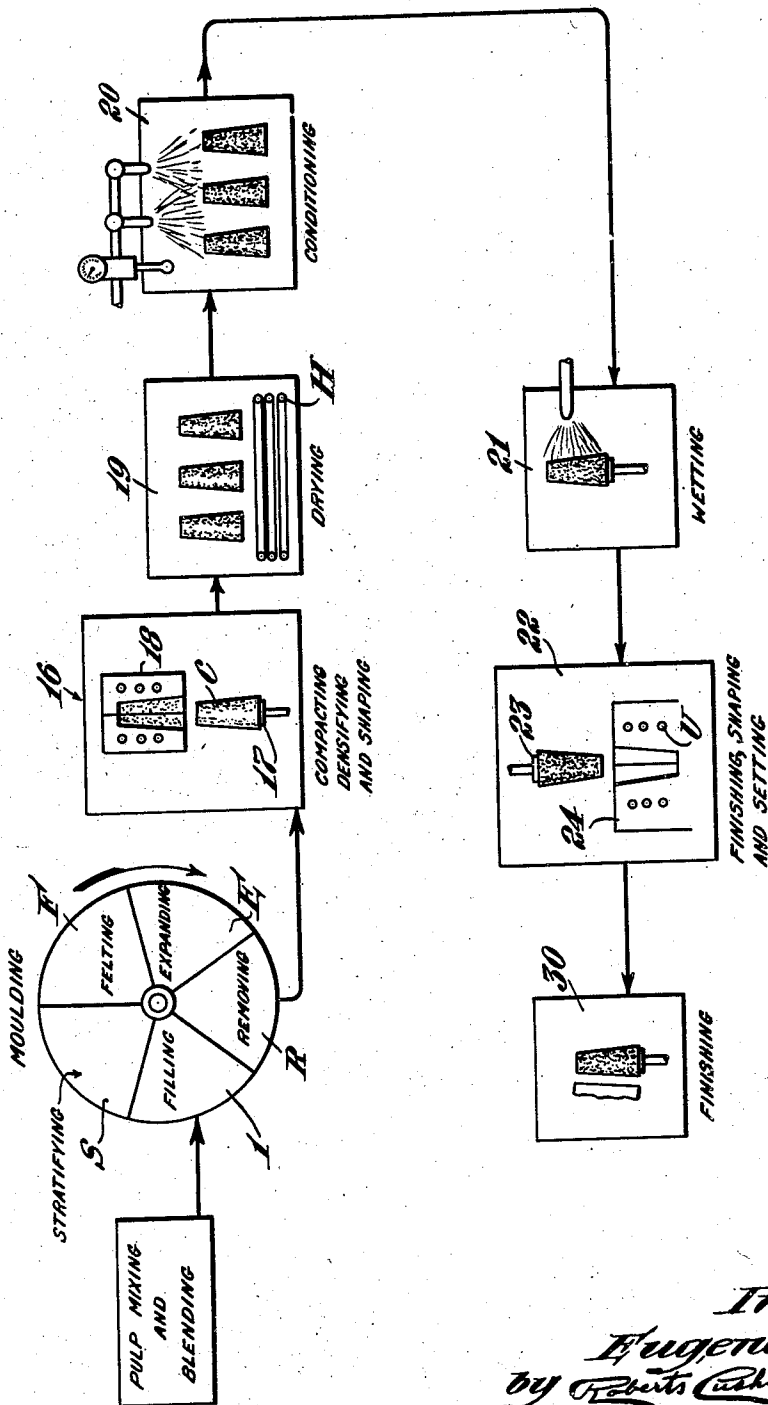


Fig. 1

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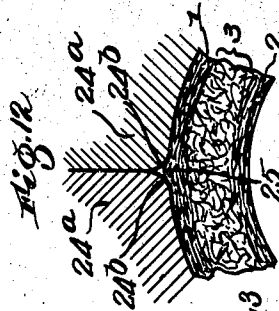
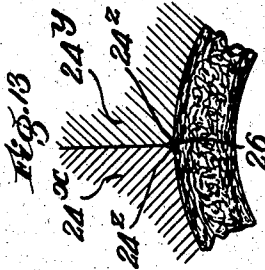
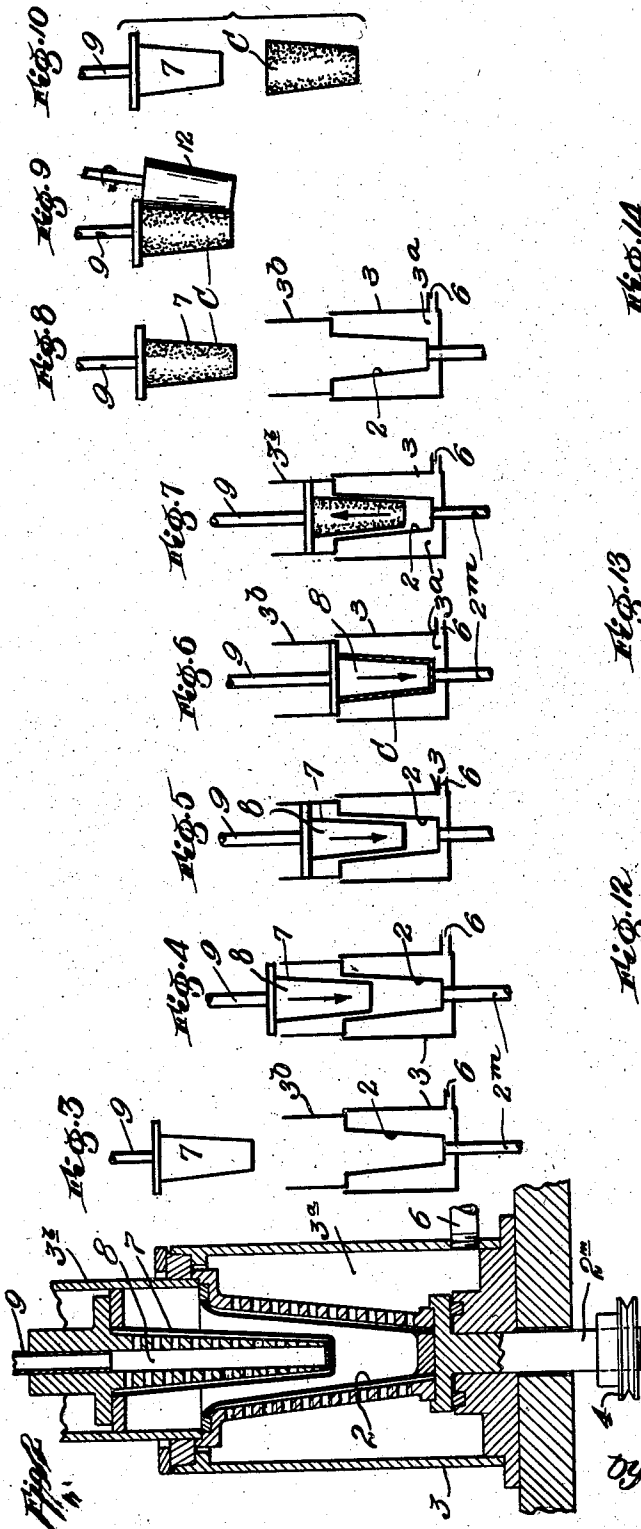
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2 Sheets-Sheet 2



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UNITED STATES PATENT OFFICE

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METHOD OF MAKING HOLLOW ARTICLES

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Application August 14, 1940, Serial No. 352,601

8 Claims. (Cl. 18—47.5)

This invention pertains to hollow articles formed from material of a fibrous nature and relates more especially to an improved method of making such articles. While the invention is of broader utility, it is hereinafter more specifically described and illustrated, by way of example, in its application to the making of a textile winding core or cone. Such winding cores or cones are employed in the textile industry as supports for wound masses of yarn or thread, the yarn or thread being wound under tension to form a self-supporting mass, package or cheese upon the headless core. Such yarn masses are commonly used to supply knitting machines or the like and when so used the yarn is drawn off from over the end of the core. To facilitate this operation the core and yarn mass are commonly tapered or form truncated cones and such tapered cores are commonly termed "cones." In the following description such tapered cores will be referred to as cones, although without intent thereby to limit the scope of the invention.

The most common prior method of making textile cores or cones is by winding paper upon a mandrel or arbor, the successive turns being united by adhesive. However, this procedure requires that the fibrous pulp stock first be made into sheet form; it requires the cutting of the sheet into pieces having curved edges (with attendant waste) for use in making tapered articles; it produces a core having an undesirable lap joint at both inner and outer surfaces; the core is not properly balanced (except great care be taken in winding it or subsequent operations be resorted to); the tapered core presents difficulties in respect to proper and permanent anchorage of a separate finish cap to its tip and it is further difficult to provide the outer surface of such a cone with a desirable form of thread-retaining finish.

It has also been proposed to make textile cones of metal, ceramic material, or by turning them from wood, but all of such expedients are unduly expensive and in many cases produce cones which are impractically heavy, require care in handling; which fail properly to retain the yarn wound thereon, or which can not easily be mounted upon the standard form of winding or unwinding arbor.

While it has been suggested that hollow articles be made by moulding paper pulp in a mould and subsequently subjecting the article to pressure, such articles ordinarily possess little strength and when it has been attempted to apply such methods to the production of textile cones the resultant article has not been strong enough to with-

stand the stresses imposed in winding the yarn thereon under tension; the mechanical blows and other stresses imposed during handling or storage; or the softening, disintegrating warping effects of moisture, steam, liquids, or a drying atmosphere.

The principal object of the present invention is to provide an improved method or process of making hollow articles by forming them from a material predominantly of a fibrous nature, in particular textile cores or cones having all the characteristics which might be desired in such articles but without substantial waste of material and at a reasonable cost. By this improved process it is possible to make acceptable winding cores of fibrous material without inclusion of reinforcing elements; to make a core which is accurately balanced about its longitudinal axis; to make a core which is strong, stiff and hard enough acceptably to resist the various stresses and reagents to which it may be subjected during use; to make a core which is light in weight, tough, resilient and non-shattering; to make a core having a smooth, inner surface which is a true conical or cylindrical surface, in accordance with the type of article being made; to provide a core having a wall which is of uniform thickness circumferentially; to make a core whose outer surface is of a thread-retaining nature and of permanent character substantially devoid of projecting fibers when so desired and comprising smoothly finished thread-retaining elements which do not interfere with the proper placing of the initial layer of yarn and which will not catch in, fray, or otherwise damage the yarn; and to provide a core having relatively hard, dense, inner and outer surfaces integrally joined, without any definite line of demarcation, with an intermediate layer of a less dense but more resilient and yielding character.

Other and further objects of the invention will be pointed out hereinafter in the following more detailed description and by reference to the accompanying drawings, in which

Fig. 1 is a diagram indicating the successive major steps in the process of making the improved cone in accordance with a preferred process;

Fig. 2 is a fragmentary vertical section illustrating preshaping or stratifying means employed in initially forming the cone from fluent material;

Figs. 3 to 8 inclusive are diagrammatic vertical sections illustrating successive steps in the

operation of preshaping the cone from the fluent material;

Fig. 9 is a diagrammatic vertical section illustrating the step of compacting and loosening the preshaped cone;

Fig. 10 is a diagrammatic vertical section showing the formed cone as it is discharged from the upper forming member;

Fig. 11 is a diagrammatic fragmentary section, perpendicular to the major axis of the improved core, illustrating the structure of the core wall; and

Figs. 12, 13 and 14 are fragmentary sections, perpendicular to the major axis of the core, illustrating successive steps in shaping and densifying the core.

The improved process as a whole is here illustrated as directed to the making of a truncated conical core or "cone", and is shown as comprising a series of steps following one another in direct succession, but while this succession of steps is desirable, it is to be understood that under some conditions certain of these steps might be omitted or that others of equivalent character might be substituted. It is further contemplated that the order of steps may in some instances be varied for the purpose of obtaining special effects, all within the scope of the invention.

As illustrated in Fig. 1 the first step in the process is that of pulp mixing and blending whereby the material from which the cores are to be made is given its proper consistency and during which the desired ingredients are properly compounded. The actual forming of the article is conveniently, though not necessarily, carried out by means of an automatic machine or machines, and reference will hereinafter be made to certain mechanical devices useful for the purpose.

After preparation of the fluent material a quantity thereof is delivered to stratifying or preshaping means by which a self-sustaining embryo cone is first formed. Preferably a measured quantity of the fiber-bearing fluent material is thus delivered to the stratifying means, such quantity of material being substantially just sufficient to supply the solids necessary to constitute the cone. Such measured quantity of material is caused to rotate and while it is still rotating the major part of the water or other solvent is removed and the solids contained in the fluent material are deposited, in the form of concentric strata and, in the case of fibrous material, the fibers are felted together to form an integral mass. The blank or embryo cone as thus formed is self-sustaining and may be removed from the stratifying means without danger of collapse or substantial deformation.

Following this initial forming operation which produces a rough blank or embryo cone, still quite wet but, as noted, self-sustaining and which exceeds in wall thickness and other dimensions those of the desired finished article, the blank or embryo cone is subjected to a compacting, densifying and shaping operation during which additional moisture is removed, the solid materials forming the cone are integrated and, in the case of fibrous materials, more closely felted, and the cone is reduced more nearly to its final desired dimensions. After this compacting operation the cone is dried. The drying operation is followed by moisture conditioning, the cones being permitted to remain in an atmosphere containing a definite percentage of moisture, during which the cones re-absorb moisture which be-

comes substantially uniformly distributed making them somewhat pliable and to a certain degree plastic, but still without softening them sufficiently to allow them to lose their shape. Following this latter step, if desired and especially if a very smooth finish be required, the outer surface only of the cone may be moistened. The cone is now subjected to a shaping and setting operation during which the binder material which forms a part of the compound from which the cones are made sets and becomes hard. At this stage, heat may be employed to cause or initiate the setting and hardening of the binder. At this time also the outer surface of the cone may have imparted thereto any suitable thread-retaining finish. After the cone has thus been reduced substantially to its final dimensions and after the binding substance has set or at least the setting thereof has been initiated, the cone is finished, for example by forming the opening at its upper end and properly smoothing and polishing the upper end, and, if desired, by applying a preformed cap thereto. The lower edge of the cone may likewise be smoothed and finished and the outer surface may be finished in any suitable way, for example by brushing, polishing or the like.

Reverting now to the first step in the process for a more detailed description, the preferred process contemplates the use of a paper stock, among other materials, for making the cone, and for this purpose the materials employed may comprise newsprint which need not be de-linked or otherwise treated, and kraft paper in such proportions as may be desired. Obviously other sources of fiber may be employed, for instance cotton, mechanically produced wood fiber, or decorticated straw, flax, ramie, or the like. Whatever the material employed, it is blended and reduced to pulp fibers with water in any desired type of paper beater, it being found that a consistency equivalent to 3½% pulp content is satisfactory. To this is added a binder in a suitable solvent, preferably with a small per cent of stearic acid or its equivalent and a small amount of paper maker's size. These elements are mixed and blended in the beater until the fibrous material has been completely reduced to the fibrous state. Obviously other paper stocks may be employed such as waste paper other than newsprint, kraft pulps, etc. Moreover, the binder employed may be of any suitable type, preferably such as sets and becomes hard and irreversible in phase after being exposed to a definite predetermined temperature. However, it is possible to use binders which are thermoplastic at temperatures above those which would be encountered during the use of the treated article, for example the softening point of a thermoplastic resin should not be below 120° C. While phenol formaldehyde resins are desirable, other binders may also be employed, for instance urea formaldehyde resins, lignin, or derivatives thereof, casein, starch, etc., and somewhat desirable results may also be obtained by other colloidal binders such as are irreversible in phase after once having set, for example, a formaldehyde-glue suspension.

To assist in binder distribution (a uniform coating of the fibers being highly desirable), the resin or other binding material may be dissolved or dispersed in water or other suitable solvents and gradually added to the fibrous material in the beater, or the binder and water may be added to a suitable emulsifying agent and agitated until an emulsion is formed which is added to

the pulp in the beater and the emulsion thereafter broken by the addition of alum or similar material. The amount of binder may vary through a considerable range, for example from 5% to 40% of the weight of the pulp, and other materials may be added to the pulp in the beater, for example, as above noted, paper maker's size and a size setting agent such as alum or a resin setting agent such as formaldehyde or its equivalent may be added, together with fillers such, for example, as talc, clay, stearic acid or the like. It is also suggested that the resin or other binding material may first be mixed with a portion only of the pulp and then this may be added to the main body of the pulp in the beater. After beating, the pulp may be held in a supply tank from which it is delivered to the preshaping or stratifying means.

While it is not necessary to the practice of the invention that the forming be carried out in an automatic machine, since the several steps of the forming may be performed one after the other by the use of hand manipulated appliances, the machine method is preferable. A desirable type of machine for carrying out this process includes a rotary turntable 1 (Fig. 1) which supports the preshaping means, and by means of which said preshaping or stratifying means may be disposed at the filling or receiving station where a predetermined measured quantity of the fiber-bearing liquid from the supply tank is delivered to the preshaping or stratifying means, and then, as the turntable revolves, the preshaping or stratifying means is carried on step by step until the embryo cone is discharged at a point near the filling station.

The preshaping or stratifying means employed is preferably such as is more or less diagrammatically illustrated in Figs. 2 to 10 inclusive. This means comprises the hollow matrix member 2 which is of foraminous or screen material properly reinforced and supported to rotate within a suction chamber 3^a formed by the fixed, outer casing 3. As illustrated in Fig. 2, this matrix 2 is of frusto-conical shape, tapering downwardly. The matrix 2 is supported upon a vertical shaft 2^m mounted to turn in suitable journal bearings. As one suitable means of rotating the shaft 2^m, a pulley 4 is here shown as fixed to the shaft 2^m, said pulley being designed to receive a belt by means of which the matrix may be rotated while the turntable 1 is revolving. The chamber 3^a is connected by means of a suitable conduit 6 with an air pump or equivalent device (not shown) whereby a subatmospheric pressure may be created when desired in the chamber 3^a. The preshaping or stratifying means also comprises the vertically movable and freely rotatable inner former or die member 7, also of foraminous or screen material, suitably reinforced and carried at the lower end of a tubular support 9, and which is guided for movement up and down within a cylindrical, imperforate upper extension 3^b of the matrix 2. The former 7 is hollow, thereby providing an interior chamber 8 which communicates by means of the tubular support 9 with a suitable air pump or the like (not shown) whereby a partial vacuum may be created in the chamber 8 in the die 7.

When the preshaping or stratifying means arrives at the filling station in readiness to receive the predetermined measured quantity of fluid from the supply tank, the former 7 has already been raised completely out of the cylindrical part 3^b (Fig. 3), thus leaving the part 3^b open at its

top so that the charge of fluid may be delivered into the matrix 2. The part 3^b and the matrix 2 are at this time rotating, the speed being determined in accordance with the consistency of the fluid mass, and the charge of fluid will begin to rotate as it enters the rotating matrix. The former 7 now moves downwardly into the part 3^b as shown in Fig. 4, thus confining the rotating charge of pulp between the foraminous surfaces of the inner former 7 and matrix 2, and the frictional action of the rotating fluid causes the former 7 to start rotating. The two tapered foraminous elements rotate about the same axis, and the body of fluid which is interposed between said elements tends to lag behind the matrix, while the speed of the die or inner former is initially less than that of the fluid. The former 7 is gradually moved downwardly into the matrix 2 (Fig. 4) while the suction devices are put into action, thus producing a partial vacuum in the chambers 3^a and 8. The partial vacuum tends to cause the fibers suspended in the fluid to deposit upon the screen walls of the former 7 and the matrix 2, but since there is a slight difference in linear velocity between the fluid and the surfaces of the respective screen members, those fibers which lie nearest to the screen members tend to align themselves with each other, that is to say, to dispose themselves so as more or less to form arcs of circles concentric with the axis of rotation. While the fibers which thus lie nearest to the screen members 7 and 2 thus tend to dispose themselves in concentric circles, the fibers in the mid-portion of the space between the screens are not so subject to this dragging action and thus are not caused to assume any particular direction and thus tend to retain their initial indiscriminate orientation. The rotation of the former 7 and matrix 2 is continued while the inner former 7 is moved farther and farther down (Figs. 5 and 6) during which time a large part of the water is removed from the pulp material, first by reason of the partial vacuum in the chamber 8 and in the space 3^a below the matrix 2. If desired, the former 7 may be allowed or caused to move down so as actually to compress the stratified material between it and the matrix 2, although such mechanical compression is not always necessary or desirable, depending upon the character of the stock being used. The result of the rotation as above described is to dispose the fibers which lie adjacent the members 7 and 2 in more or less concentric arcs as indicated at F¹ and F² (Fig. 11) whereas the fibers at the intermediate portion of the walls of the embryo cone thus formed are indiscriminately oriented as indicated at F³ (Fig. 11). The fibers at F¹ and F² thus form outer and inner strata or skins in which the fibers are densely disposed and nearly parallel with one another, while in the intermediate stratum F³ they are more loosely arranged and not as compact or dense as in the outer layers. This layer F³ thus provides a cushioning effect and a tough although somewhat yielding backing for the outer strata which, during the completion of the cone become very hard and dense as compared with the tougher and more yielding inner stratum. It should be noted that the three strata F¹, F² and F³ are formed at one and the same time from the initial measured charge of fiber-bearing fluid and are integrally joined and knitted together.

These operations of stratifying and compacting the fiber by rotation and by the pressure of the die or inner former 7 within the matrix 2

take place during the rotation of the turntable I through the stations S and F (Fig. 1). As the preshaping or stratifying means leaves the latter station, the part 7 begins to rise, but just before it begins to rise, atmospheric pressure is admitted to the chamber 3^a although the partial vacuum is still maintained within the chamber 8. During the elevation of the former 7, the rotation of the matrix 2 is preferably stopped. As the inner former 7 begins to rise with the partial vacuum still maintained in the chamber 8, the embryo cone C is separated from the matrix 2 and rises with the former 7.

When using certain types of stock, it is desirable to cut off the partial vacuum from former 7 after the cone has separated from the matrix 2, the cone being sufficiently adherent to the former 7 to stick to the latter without the partial vacuum.

The preshaping of the embryo cone as thus described is quite distinct from usual casting or moulding operations, first, in that the fluent material delivered to matrix 2 is in measured quantity just sufficient to furnish the solids requisite to constitute the finished cone, so that no fins, burrs or other waste are initially formed to require subsequent removal; and second, in the disposition of the fibers in concentric strata of definitely different characteristics but with such strata integrally merged with one another.

A compacting roll 12 (Fig. 9) is now caused to bear against the outer surface of the thick, wet embryo cone C at the station E (Fig. 1) and the cone is rotated while the roll 12 is gently pressed against its outer surface. The partial vacuum may again be established in the chamber 8 during the latter part of this operation if desired, and the water which is forced inwardly by the pressure of the roll 12 is sucked away, thus further compacting the cone. When the cone is sufficiently freed from water and sufficiently compacted, atmospheric pressure is admitted to the chamber 8 and the cone makes about one more revolution in contact with the roll, thus expanding the cone slightly in diameter and facilitating its removal from the inner former 7. The preshaping or stratifying means now passes from station E to station R, and the cone (having now left the roll 12) is loose on die 7. At station R the embryo self-sustaining cone C is removed from the die or inner former 7 (Fig. 10) and may be conveyed to the next station in any desired manner.

The embryo cone C is now subjected to the compacting, densifying and shaping operation at station 16, Fig. 1. Here the wet cone is supported, for example, upon a hollow form 17 made of foraminous material and whose interior is connected by a suction conduit to a vacuum pump or the like. The embryo cone is subjected to the action of intermittent pressure-applying means which is caused to exert repeated pressure upon the outer surface of the cone.

Preferably the pressure-applying means employed in this operation is a multi-part matrix 18 whose walls are foraminous, perforate, or otherwise at least pervious to air so that air can freely enter and thus facilitate the withdrawal of water inwardly by the suction pull acting through the foraminous walls of the support 17. This operation may be completed by means of a single support and cooperating matrix device, the cone preferably being rotated slightly intermediate successive applications of pressure thereby to minimize the formation of longitudinal ribs at

the parting lines of the matrix. During this operation also, the tip may be given special treatment as by the use of a suitable rigid former, to insure proper configuration at this point. It is preferred to carry on this operation at station 16 in a series of steps by the use of a series of matrix devices preferably of successively smaller internal dimensions whereby the wall of the cone is gradually compacted and reduced in thickness, the core being turned, as it is transferred from one matrix to the next, so that the slight ribs formed at the parting lines of the earlier matrices are ironed out by contact with the walls of the later matrices.

Although during this time the arrangement of the fibers to constitute concentric strata is not disturbed, the fibers are compacted together and to a certain extent felted, the wall thickness decreases to some extent; and the cone approaches more nearly the dimensions of the desired finished cone.

After this compacting operation the cone is moved to the station 19. Here the cone is placed in a drying chamber, while supported upon a suitable form if desired, and is dried, either by a desiccating atmosphere, radiant heat from a heating coil H or the like, or in any other appropriate way. If heat be used in thus removing excess moisture, care should be taken that the heat is not high enough to cause a setting of the binding material.

The "semi-finished" cone may now be stored so long as desired, being dry, hard and dense and with a well defined three-strata structure. This structure is of distinct advantage since the outer and inner hard surfaces with their fibers running generally circumferentially provide an arch effect capable of withstanding heavy radial pressure, while, on the other hand, the intermediate more resilient layer provides a cushion backing for these outer dense and relatively hard skin surfaces. These dense outer surfaces are resistant to abrasion both from the action of the thread on the outside and from contact with the rotating spindles upon which the cones are slipped in readiness for winding. The cone may be subjected to a very considerable degree of heat without surface blistering.

In order to ensure substantial uniformity in moisture content, the cones are now placed in a conditioning chamber 20 wherein the humidity is carefully regulated. The exposure of the cones to an atmosphere having a definite predetermined degree of humidity is of sufficiently long duration to ensure that the cone will have just enough moisture so that its fibers will be soft, flexible, and capable of being densely compacted without rupture.

The next operation, which is optional, dependent upon the degree of surface finish desired, is performed at the station 21. Here the outer surface or layer of the cone may be wet so as to soften it slightly and put it in readiness for receiving the final surface pattern. This wetting may be done by immersing the outer surface for a few seconds in hot water or by spraying the cone while rotating it upon a suitable support, but care should be taken not to permit the moisture to reach the inner surface or the interior of the cone.

If sufficient soft fillers, for example waxes or low melting point resins, are incorporated in the mixture in the beater, a suitable fine finish may be obtained at the next station 22 without recourse to the wetting operation at station 21.

The cone is now carried to the station 22 where the cone is subjected to heat and pressure in order to set the binding and stiffening material, for example the resin, so as to impart to the cone its final desired hardness and ability to withstand the softening action of reagents to which it may be subjected. The cone reaches this stage with substantially the same shape and dimensions as were imparted during the densifying operation, and it may leave station 22 with a smooth outer surface finish, if desired, but with its constituent fibers further compacted and permanently bound together by the setting of the binding material.

At this stage, the cone is fitted onto a rigid die 23 having a smooth outer surface of true right conical contour and which fits the inner surface of the cone very snugly. Then a rigid multi-part matrix 24 is caused to bear against the outer surface of the cone. The matrix, as indicated in greater detail in Figs. 12, 13 and 14, is a divided matrix, preferably comprising three or more parts, portions of two adjacent parts 24^a being shown in Fig. 12. At the parting line where these parts 24^a abut, their inner corners 24^b are smoothly rounded or beveled. Thus at the parting, the material of the core is not pinched up into a sharp fin but merely bulges to form a rounded protuberance 25 wherein the fibers are bent but not ruptured.

Preferably the operation at the station 22 is carried out as a plurality of steps in a series of shaping devices all alike except for the shape of the parts of the matrix 24. Thus the cavity defined by the matrix members 24^x and 24^y may, if desired, be of an internal diameter slightly less than that formed by the matrix members 24^a of Fig. 12, their inner corners 24^b, at the parting line, being rounded off on slightly shorter arcs of curvature. When introducing the partially completed cone into this second set of matrix members 24^x, 24^y, the cone is so rotated that the boss 25 is offset with reference to the parting line between the matrix parts 24^x and 24^y. Since at this time the material of the cone is somewhat denser than when it was introduced into the first shaping device (Fig. 12) the protuberance 26 formed at the junction of the two matrix members is smaller than that produced by the operation of the members 24^a.

A third set of matrix members 24^m (Fig. 14) may also be employed to impart a further densification to the cone. At the parting line these members may have their inner meeting corners 24^a rounded off on a still smaller radius, and at this time the cone is so dense that as the matrix members approach they form an outstanding rib or protuberance too small to be of any practical importance. As in the preceding step, the cone is rotated slightly before entering it into the space defined by the matrix members 24^m so that the protuberance 26 does not come opposite the parting between the parts 24^m, the space being of slightly less internal diameter than that of the mould of Fig. 13. By the above-described succession of steps the protuberances 25 and 26 formed in the less dense cone are ironed out by the smooth circumferential inner surfaces of the individual matrix members in succeeding stages, and at the last stage of densification the protuberance formed, if at all, is so slight as to be unobjectionable, so that the outer surface of the cone at this stage is substantially devoid of objectionable longitudinal ribs or fins, although the locations of the smoothed-out protuberances 25

and 26 may be evident by slight color variation or as almost imperceptible elevations when viewed tangentially.

As above suggested, each set of matrix members may, if desired, be made to provide a cone-receiving cavity of somewhat less dimensions than the preceding ones, so the cone is gradually reduced in thickness and caused to approach its final desired dimensions. Since these several sets of matrix members differ from each other but slightly in dimensions, the reduction in thickness of the cone is gradual and the constituent fibers are not broken even at the parting points of the matrix members. Thus the resultant cone is of very great strength and density and capable of withstanding much greater stresses without breakage or collapse than cones moulded by usual methods.

During this operation the cone is subjected to a temperature such that the binding material becomes harder and preferably irreversible in phase. If desired, a yarn-retaining finish may be imparted to the outer surface of the cone concomitantly with the setting operation. When several matrices 24 are used in succession, they may all be heated if desired, for example by electric heating units U, although the temperature at the earlier stages should not be such as to cause premature hardening or setting of the binding material. It is possible, by proper heat and pressure treatment to impart a velvet finish to the surface of the cone. On the other hand, the inner surface of the matrix member 24 may have engraved thereon or otherwise provided, in intaglio, a pattern which it is desired shall appear in cameo on the outer surface of the cone. For instance, the inner surface of the member 24 may be provided with a multitude of circumferentially extending minute grooves or recesses of suitable cross section. Such recesses, if properly shaped, will produce upon the outer surface of the finished cone a series of circumferentially extending ribs desirable for holding the yarn and preventing its slippage. Preferably the pattern thus imparted to the outer surface of the cone should be made of a character such that, in impressing it into the substance of the cone, the constituent fibers of the cone will not be broken by the action of sharp cutting surfaces. Rather, the fibers will be bent gently to form ribs or other projections having smoothly rounded outer surfaces such as will not roughen or abrade the yarn when it is wound on the cone but which at the same time will provide a permanent retaining surface which will not wear off readily and which will provide a high degree of friction such as to prevent yarn, even of the wiry character of rayon, from sliding off the cone or converging toward the center.

If desired, as above suggested, the finish-forming devices at station 22 may be so arranged as to impart to the tip of the cone a finish different from that given to the body of the cone. For instance, the texture of the tip may be made so hard and smooth, by the application of greater heat and pressure than is applied to the body of the cone, that no further tip finishing or forming may be necessary to make the cone acceptable for certain uses. It is also possible, as above suggested, by a proper control of the heat at station 22, and by proper control of the amount of moisture applied at station 21, to impart almost any desired finish, including a velvet finish, to the winding surface of the cone. It is not entirely necessary that the setting of the binding material be com-

pleted while the cone is at station 22, since some types of binder set gradually after setting has once been initiated, for example by a sufficient degree of heat. To ensure such action with some types of binder, it may be necessary to add a material capable of causing such completion of setting. One such material suitable for use with the phenol resins is hexamethylene-tetramine. If desired, the initially or partially cured cones may be removed from station 22 before "setting" is completed, and thereafter introduced into an oven maintained at the proper temperature to complete the "cure." The operation can thus be performed without extreme heat or pressure. As in the densifying operation performed at station 16, the finish shaping at station 22 may be performed as a series of steps in a series of matrices, each having a cavity slightly smaller, if desired, than the preceding, and in introducing the cone into each successive matrix cavity, it will be turned so that any minute rib formed at the parting of a previous matrix will be out of registry with the parting of the matrix into which it is being placed.

After the cone has thus been subjected to heat and pressure so as to set the binding material and to impart the outer surface contour to the cone, the cone is then carried to the finishing station 30 at which various finishing operations may be performed, some of which may be omitted if desired. For example, the top of the cone may be punched to leave an opening and the rough surface resulting pressed to provide a more smoothly rounded tip. A separate cap or tip finish may be applied; for example, a cap such as is disclosed in the copending application of Bates and Morse, Serial No. 352,594, filed August 14, 1940, may be applied to the tip portion of the cone prepared as above described. Instead of applying a separate cap or tip it is possible to produce a smoothly finished tip as an integral part of the core. This may be accomplished by the use of properly configured formers having smoothly polished surfaces designed to impart a corresponding surface to the tip of the core. The perfection of the finish may be enhanced by using modifications of the resin mixture in the original fibrous mass so that greater surface polish may thereby be obtained (as by the use of lower melting resins) combined with heat applied at the tip-forming portions of the formers, and even smoother finish may be obtained by subjecting the tip to the action of a heated polished burnishing element which exerts pressure axially against the tip portion of the core, or which, if desired, may be rotated relatively to the core. Alternatively, a tip finish may be provided by dipping, spraying, or brushing lacquer or enamel upon the top of the cone. The bottom of the cone may also be smoothed, as by trimming and/or grinding, if desired, to provide an even, lower edge surface perpendicular to the axis of the cone. Moreover, the entire outer surface of the cone may, if desired, be waxed or given any other surface finish or treatment which may be desired.

While the above description has been related particularly to the formation of a cone or winding core of frusto-conical shape, it is to be understood that the invention in its broader aspects is applicable to the manufacture of textile cores or even other hollow articles of circular cross section from fibrous material such as paper stock, and particularly when it is requisite that such articles shall be very strong and durable but of light weight, and when it is important that

the article be as nearly perfectly balanced as possible about its major axis. Such balance, in accordance with the present invention, results from the mode of stratifying the material from a measured charge which is rotated so that the walls of the embryo core are necessarily of uniform thickness at every transverse cross section and form true circles both at their inner and outer circumferences, the formed core being devoid of projecting fins, burrs, or other irregularities such as result from ordinary casting or moulding operations. When this procedure is followed, the embryo cone or other article which results has its walls of such uniform character that subsequent operations merely act to compact these walls and to reduce their thickness and without requiring that the thickness of the wall be changed from point to point so as to bring about a balance.

For certain types of cone, for example cones for use in winding cotton, it is not necessary to have as great strength or as high a quality of finish as that which results from the process in all of its details as heretofore described. Thus in making certain grades of cone it is possible to employ cheaper resins or sizes than those above referred to, and the character of the use to which some cones are subjected permits elimination of certain of the above-described operations, such, for example, as repeated pressings, separate drying and conditioning operations, etc., as well as a reduction of the time of beating the pulp in preparation for cone forming and the substitution of cheaper sources of fiber, such as mechanically prepared wood fiber, etc.

While certain desirable process steps have been described as useful in attaining the desired result, it is to be understood as above suggested that other and equivalent steps may be substituted and that the order of steps may be changed and that some steps may be omitted, all within the scope of the invention as pointed out in the appended claims.

I claim:

1. That method of treating a soft, wet, pulpy, thick-walled, hollow blank of annular transverse section and comprising fibrous material thereby to produce a textile winding core having relatively thin dense walls and which is strong, stiff and light in weight, said method comprising as steps subjecting the blank to densifying pressure, the pressure being applied in a plurality of successive steps in a corresponding number of multi-part matrices, each slightly smaller in internal dimensions than the preceding, thereby gradually increasing the density and decreasing the size of the core.

2. That method of treating a soft, wet, pulpy, thick-walled, hollow, annular blank comprising fibrous material thereby to produce textile winding core having relatively thin, dense walls and which is strong, stiff and light in weight, said method comprising as steps subjecting the core to densifying pressure in a multi-part matrix having a blank-receiving cavity of circular transverse section, the pressure being applied in a plurality of successive steps and the blank being partially rotated relatively to the matrix partings intermediate successive steps, thereby to prevent formation of appreciable fins at the matrix partings.

3. That method of treating a soft, wet, pulpy, thick-walled, hollow, annular blank comprising fibrous material thereby to produce a textile winding core having relatively thin, dense walls

and which is strong, stiff and light in weight and whose inner and outer surfaces are substantially true, coaxial surfaces of revolution, said method comprising as steps providing a plurality of multi-part matrices, each having a substantially circular, blank-receiving cavity and each being of slightly smaller internal dimensions than the preceding, the larger matrix having its inner corners rounded at its partings, the next matrix in sequence having its inner corners rounded at its partings but to smaller radii than those of the preceding matrix, and the last matrix having rounded inner corners at its partings of still smaller radii, compressing the blank in each of the several matrices successively, beginning with the largest and ending with the smallest, and so disposing the blank in placing it in each successive matrix that the ribs formed by the partings of the larger matrices do not register with the partings of the succeeding smaller matrices.

4. That method of treating a soft, wet, pulpy, thick-walled, hollow, annular blank comprising fibrous material thereby to produce a textile winding core having relatively thin, dense walls and whose inner and outer surfaces are substantially true, coaxial surfaces of revolution, said method comprising as steps compacting the blank and, while the blank is moist, subjecting the blank to repeated shaping pressure in multi-part matrices each having a blank-receiving cavity of circular transverse section while rotating the blank intermediate successive applications of pressure so that the parting lines of the several matrices engage the outer surface of the blank at successively different points in the periphery of the latter.

5. That method of treating a soft, wet, pulpy, thick-walled, hollow blank of substantially circular transverse section and comprising fibrous material and a thermo-setting binding medium thereby to produce a hollow article having relatively thin, dense walls and whose inner and outer surfaces are substantially true, coaxial surfaces of revolution, said method comprising as steps mounting the blank upon a hollow foraminous-walled former of circular transverse section, applying mechanical pressure to the exterior of the blank by means of a rigid, multi-part matrix having a blank-receiving cavity of circular transverse section while maintaining a partial vacuum within the former, the pressure being applied intermittently, partially rotating the blank relatively to the matrix between successive applications of pressure, and drying the compacted blank thereby providing a semi-finished article capable of being handled without injury, thereafter moistening the dried article to soften its fibers, subjecting the moistened article to mechanical pressure between rigid die elements thereby to reduce it substantially to the desired final shape and dimensions, and while so pressing it, heating it, thereby to set the binding medium.

6. That method of treating a soft, wet, pulpy, thick-walled, hollow blank of substantially circular transverse section and comprising fibrous material and a thermosetting binding medium thereby to produce a hollow article of annular transverse section having relatively thin walls and which is strong, and stiff and whose inner and outer surfaces are substantially true, coaxial surfaces of revolution, said method comprising as steps mounting the blank upon a foraminous walled hollow former of circular transverse sec-

tion, applying compacting mechanical pressure to the exterior of the blank by means of a rigid multipart matrix having a blank-receiving cavity of circular transverse section while maintaining a partial vacuum within the former, the pressure being applied intermittently, partly rotating the blank, relatively to the matrix, through an angle different from that subtended by adjacent parting lines of the matrix, between successive applications of pressure, whereby ribs initially formed at parting lines of the matrix are ironed out, drying the compacted blank, thereafter moistening the blank throughout its entire thickness to soften its fiber, and subjecting the blank to mechanical pressure between rigid heated die elements thereby to reduce it substantially to the desired final shape and dimensions and to set the binding medium, and, while so subjecting it to mechanical pressure, imparting a yarn-retaining pattern to its outer surface.

7. That method of treating a soft, wet, pulpy, thick-walled hollow blank of substantially circular transverse section and comprising fibrous material and a thermosetting binding medium thereby to produce a hollow article having relatively thin, dense walls and whose inner and outer surfaces are substantially true coaxial surfaces of revolution, said method comprising as steps mounting the blank upon a hollow foraminous walled former of circular transverse section, applying mechanical pressure to the exterior of the blank by means of a rigid multi-part matrix having a blank-receiving cavity of circular transverse section while maintaining a partial vacuum within the former, the pressure being applied intermittently, partially rotating the blank, relatively to the matrix, through an angle different from that subtended by adjacent parting lines of the matrix, between successive applications of pressure whereby ribs initially formed at parting lines of the matrix are ironed out, and drying the compacted blank thereby providing a semi-finished article capable of being handled and stored without injury.

8. That method of treating a soft, wet, pulpy, thick-walled hollow blank of substantially circular transverse section and comprising fibrous material and a thermosetting binding medium thereby to produce a hollow article having relatively thin, dense walls and whose inner and outer surfaces are substantially true coaxial surfaces of revolution, said method comprising as steps mounting the blank upon a hollow foraminous walled former of circular transverse section, applying mechanical pressure to the exterior of the blank by means of a rigid multi-part matrix having a blank-receiving cavity of circular transverse section while maintaining a partial vacuum within the former, the pressure being applied intermittently, partially rotating the blank relatively to the matrix between successive applications of pressure, and drying the compacted blank thereby providing a semi-finished article capable of being handled and stored without injury, thereafter moistening the article to soften its fibers, and while it is moist subjecting it to repeated shaping pressure in multi-part matrices each having a blank-receiving cavity of circular transverse section while rotating the article intermediate successive applications of pressure so that the parting lines of the several matrices engage the outer surface of the article at successively different points in the periphery of the latter.

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