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CORELESS YARN AND PROCESS FOR MAKING THE SAME

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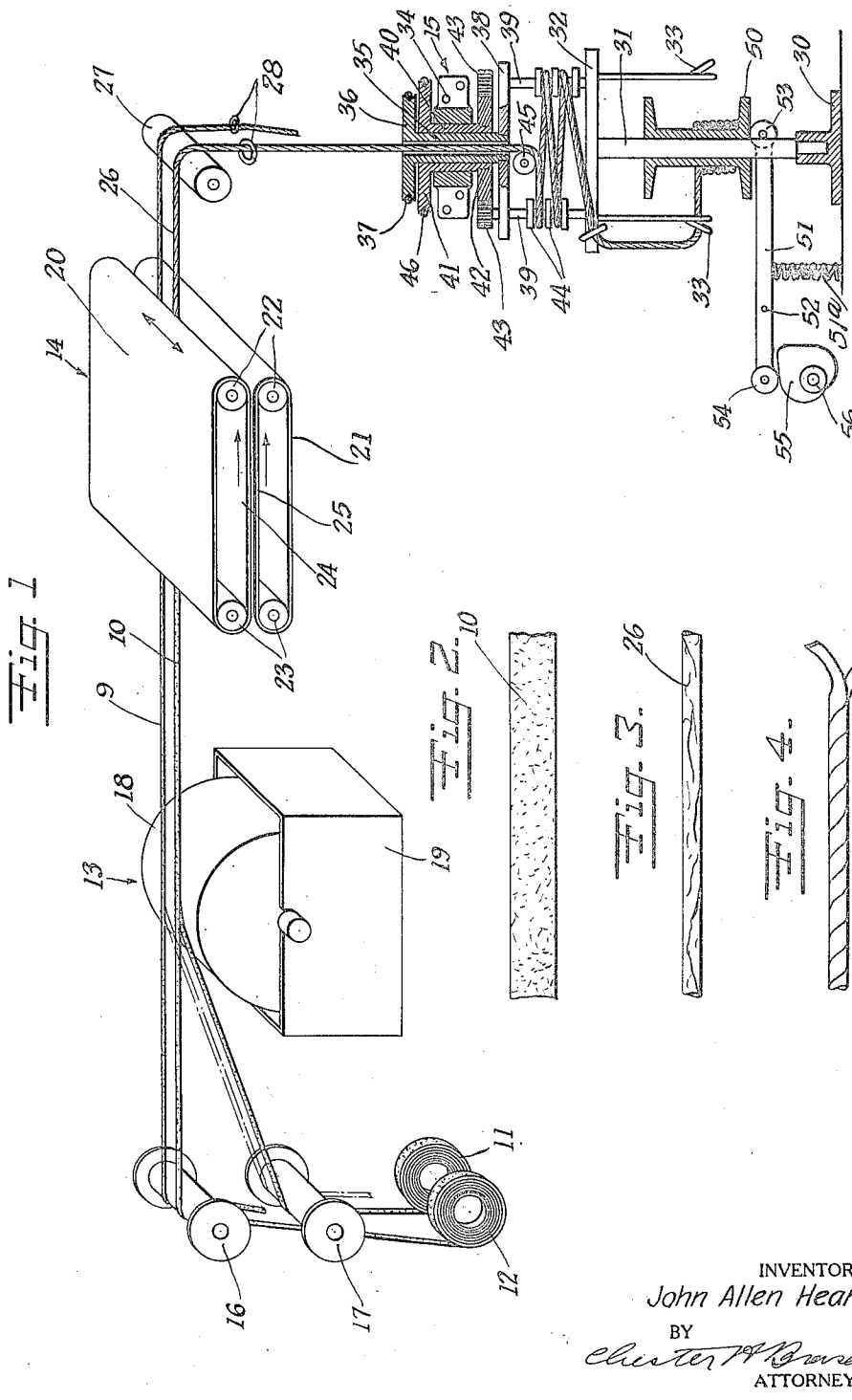


Fig. 1

Fig. 2.

Fig. 3.

Fig. 4.

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CORELESS YARN AND PROCESS FOR MAKING THE SAME.

Application filed January 4, 1924, Serial No. 684,324. Renewed January 28, 1926.

This invention relates to yarn and the process of making the same from asbestos paper-like material or asbestos paper-like strips or bands without the utilization of centering or reinforcing filaments or cores. The invention has specific utility in connection with a yarn including asbestos material, bound and formed into a thin paper-like strip or band of sufficient cohesiveness and tenacity to undergo subsequent strand and yarn forming operations or adapted for yarn manufacture. In a specific form the invention consists in running one or more paper-like strips or bands of asbestos material over a moistening device, subsequently shaping and rounding the moistened strips by means of a rubbing mechanism to form separate strands, and then twisting each strand or intertwisting strands to form a final yarn.

Among the objects of the invention is the provision of a process of manufacture by means of which a substantial yarn may be obtained from asbestos material which normally has relatively small coherence and tensile strength. Another important object of the invention is the utilization of a process which will make available for yarn manufacture asbestos fibre in all lengths as produced, the mode of manufacture being independent of the length of the fibre or the natural coherence of the fibres between themselves. Important uses of the yarn of this invention are in connection with the manufacture of friction fabrics such as brake and transmission linings and in the manufacture of other fabrics requiring heat and wear resisting qualities. A further object is the provision of an all paper asbestos yarn. An important object of the invention is to provide a coreless or unreinforced asbestos material present in the yarn in paper-like formation and bound together with sufficient cohesiveness and tenacity to retain such paper-like formation. Another object of the invention is to provide a coreless asbestos yarn consisting of asbestos material present in paper-like strip formation and bound together, as by binding material, with sufficient cohesiveness and tenacity to undergo strand and yarn forming operations or adapted for strand and yarn forming operations. A further object is to provide a coreless asbestos yarn including a plurality of strands of asbestos paper-like material bound together with sufficient cohesiveness and tenacity to undergo strand and yarn forming operations. Further objects are comprehended in the employment of a step of loosening the binder of the paper in conjunction with a rolling or rubbing process and a twisting operation, whereby a tenacious, coherent yarn is formed; in the provision of a process which includes only three major steps in transforming an asbestos paper strip to a yarn; in the provision of a process for making yarn from paper strip which consists in loosening the binder of two or more paper-strips, simultaneously passing said strips together in contacting relationship with adjacent forwardly moving and transversely reciprocating surfaces to form a strand and finally twisting said strand to form a yarn; in the provision of a method of making coreless asbestos yarn from strips or bands of asbestos material bound with sufficient cohesiveness and tenacity and adapted for yarn manufacture, which includes the step of forming a plurality of said strips or bands without tension reinforcement into a yarn; in the provision of a method which includes mechanically forming, as by suitable mechanical means, said paper-like material without tension reinforcement into strands, and thereafter mechanically forming a plurality of such strands into a yarn and in other features associated with the specific type of mechanism utilized and in the detailed steps of the process as will appear from a consideration of the apparatus and its operation in connection with the general process of manufacture, as hereinafter indicated and described in the accompanying drawings.

For the purposes of this disclosure, as illustrative of one of the forms of the invention which may be preferred,

Fig. 1 shows diagrammatically the major elements of an illustrative form of the mechanism involved in the process, some of these elements being in perspective and others in cross section;

Fig. 2 is a view of the paper strip used in the process of manufacture;

Fig. 3 is a view of a strand formed from the paper strip prior to its introduction into the twisting mechanism; and

Fig. 4 is a view of the completed yarn, showing an unravelled end of the same.

It should be understood that the process

hereinafter described is particularly adapted for the manufacture of coreless or unreinforced strands and yarns from asbestos paper-like material, which may be in the form of strips or bands.

As is well known, asbestos fibre, as obtained from the mineral asbestos, is relatively short in length and brittle. There is, morever, relatively slight coherence between the different fibres of the asbestos as compared with vegetable fibre, for example, thus tending to make the formation of a yarn or fabric difficult. The present practice in the manufacture of yarn has been to reinforce the pure asbestos fibre with additional fibres of vegetable material such as cotton or jute which serve as reinforcement and means for retaining the asbestos fibre in position. The long fibre may be added either during the formation of an asbestos strand or yarn by twisting or by compacting or moulding the asbestos about a continuous strand of cotton or metal, thus producing a compound yarn, formed of asbestos material and filamentary strand of either vegetable fibre or metal.

For certain uses, yarns, made as indicated above with the addition of reinforcing fibres, are undesirable. For example, where a yarn is desired which is to be used in heat resisting relationships, the employment of cotton fibre as a reinforcement is highly undesirable, the high temperatures carbonizing the fibre and thus permitting disorganization of the entire yarn structure. Such disadvantages may be avoided by the use of yarns of asbestos paper-like material such as disclosed herein. In certain instances also the yarn fabric should not only be heat resisting, but also so pliable that it can be woven into a relatively fine texture, and, inasmuch, as the use of metal cores or filaments for asbestos yarn tends to stiffen the strand, in these connections, the use of ordinary metal reinforcements is undesirable in yarns for some uses.

The invention, as hereindescribed, contemplates the production of a yarn in which the undesirable features above enumerated are eliminated. The process involved is as follows.

The asbestos employed in the process, whether of short or long fibres or whether a mixture of the two, is formed into paper rolls preferably in the manner described in the apparatus of the present inventor, copending herewith, Serial No. 516,129, filed Nov. 18, 1921. In accordance with this process, the binding material, which may include binding material such as starch is used to hold the fibre and asbestos together in proper form, this binder being in certain cases partially removed in the manufacture of the yarn, as will be hereinafter detailed

As described in said co-pending application, the asbestos material is formed into a pulp and passed through an ordinary paper-making machine to form a web which is rolled up in the usual manner. This web, which in the paper making operation has been rendered sufficiently dry and compact to have the necessary strength, is separated by a slitting machine into narrow strips to be utilized in yarn manufacture. Satisfactory results are obtained by combining with the asbestos material in the pulp suitable binding material which serves to increase the strength of the finished web or paper, thus rendering it suitable for manipulation in the yarn making operation. The asbestos paper is applied to the mechanism of the invention in the form of a strip or tape 10, as indicated in Fig. 2, and is wound in rolls 11 and mounted on spools 12. The major elements of the mechanism include the moistener 13, a condenser 14 and a twister 15, these elements being placed adjacent each other in position to permit of a continuous feed of the material being worked upon from one member to the other. As illustrated, the tape is unreeled from the spools 12 over guide rollers 16 and 17, one of which is mounted below the other so as to facilitate feeding to the moistener 13. The tape is fed flat over the moistener roll 18 which in turn is rotatably mounted in the walls of the tank 19. The tank is adapted to contain water or any other moistening liquid and the roller 18, as clearly indicated by Fig. 1, has a portion of its body extending above the level of the liquid so that as it rotates, liquid carried up on its surface, enters the paper strip and moistens the same.

After leaving the moistener roll 18, the paper strip is fed in to the condenser 14 which comprises two facing belt structures 20 and 21, mounted on parallel rollers 22 and 23. The adjacent faces 24 and 25 of these belts are adapted to move in a forward direction and at the same time reciprocate laterally and simultaneously in opposite directions, thus seizing upon the paper strip as it progresses through the condenser and manipulating it in such fashion by rubbing and rolling that it emerges at the forward end of the condenser as a smoothly rounded strand 26, as illustrated in detail in Figure 3. It should be understood that, although the strip is formed into a rounded strand, that the paper retains its original paper structure, being closely folded or crinkled in the shaping operation.

The strand 26, while still moist, is led over the guide roll 27 through the guide loop 28 and either alone or simultaneously with one or more other similar strands into the twister 15 where the strands are subjected to the final step of the process.

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A usual form of twisting mechanism is indicated. On the base 30 is mounted a rod 31, carrying a horizontal cross plate 32 from the ends of which are suspended the guides 33. Supported above the cross bar 32 by means of a bracket 34 are the twist and feed drives of the twister. The twist drive includes a hollow sleeve 35, on the top of which is mounted a drive pulley 36 grooved at its periphery to receive the pulley belt 37. The lower end of the sleeve 35 connects by means of a cross bar 38 and shafts 39 the lower cross bar 32, so that rotation of the drive pulley 36 imparts rotation to the cross bar 32 with its depending drive guide loops 33. The feed drive includes the sleeve 40 mounted on the drive sleeve 35 and carrying in its upper end drive pulley 41 and at its lower end the gear 42. The shafts 39 pass upwardly through the cross bar 38 and terminate in pinions 43, the same engaging with the gear 42 and being adapted to be driven thereby. The shafts 39 carry guide rollers 44, there being two on each shaft; another guide roll 45 is loosely mounted beneath the cross bar 38. It is thus seen that when power is applied to the twist drive through the pulley belt 46, rotation is imparted to the stub shafts 39 and their attached rollers 44, feeding the yarn at a rate determinable by the speed of operation of the pulley and variable at will.

The yarn is wound upon a spool 50 which is loosely mounted upon the rod 31 and adapted to have a reciprocating movement thereupon. Reciprocation is imparted to the spool 50 by means of cam operated mechanism, diagrammatically indicated by lever 51, the same being pivotally mounted at 52 and carrying at either end contact rollers 53 and 54. The contact roller 53 has engagement at the base of the spool 50, while the roller 54 has engagement with the heart-shaped cam 55 rotatably mounted at 56 and serving to swing the lever 51 against the action of a spring 51^a. Inasmuch as that portion of the rod 51 intermediate the pivot 52 and roller 53 is much longer than the remaining portion of the rod, rotation of the cam 55 causes an appreciable movement of the spool 50, this movement being timed so as to take care of the yarn fed from the twisting mechanism, the yarn being wound in layers on the spool.

The strand 26 on entering the twister 15 is, as follows from a description of the twister, subjected to a certain number of twists per unit length of strand, depending upon the adjustment of the mechanism and emerges as a tenacious yarn 60, the various fibres being moulded and twisted into close coherent relationship, one with the other.

From the foregoing, the operation of the mechanism and the various steps of the process should be apparent, the paper strips 10 passing from the rolls 12 are softened by the moistening device 13 and then are fed into the rubbing mechanism, where the tapes are condensed and rubbed into strands all having approximately circular cross sections. The strands are then subjected to the twisting action of the twister, either separately or in conjunction with other strands, the final product emerging as a closely wound yarn such as, for example, where two strands are used as illustrated in Fig. 4.

Where a single strand is passed through the twister, the tensile strength will, of course, be less than that where a plurality of strands are employed. In order to multiply the strength of the single strands, additional strands are passed through the twisters simultaneously, Fig. 4 indicating a yarn formed of two strands twisted together and Fig. 1 showing an additional strand 9 lying in the mechanism and adapted to be inter-twisted with the strand 10 in the twister 15. Attention is directed to the fact that not only is the whole yarn twisted, but each strand of the yarn is subjected to the separate twist which tends to bind the individual fibres of asbestos into a compact unit. Consequently, when the two strands are twisted together, each tends to hold the other in position and thus form a final structure of high tenacity and coherence.

Where multiple strips are used to form a strand, as shown in Fig. 1 and Fig. 4, the strips are preferably fed one above the other so that in the rubbing operation the plural strips are rolled and compacted together. This operation, moreover, by increasing the tensile strength of the strand per unit area, facilitates twisting action without breakage. When the yarn is completed and dried, the individual strips still maintain their unitary characteristics and through the multiple folding and twisting thereof with contiguous strips and adjacent strands, the tensile strength and resistance to removal of fibrous stock in the completed yarn is materially increased.

As illustrated in Fig. 1 and described in connection therewith the asbestos paper-like material in strip or band form is moistened before its formation into strands or yarns. Such moistening acts to soften or loosen the binder of the paper-like material and render the latter more flexible and pliable and therefore more easily manipulated in the strand and yarn forming operations.

Note should be made that means other than that indicated may be employed for loosening the binder of the paper, the moistening device being merely illustrative of one method by which this end may be accomplished. For example, the binder of paper may be loosened or partially eliminated by a mechanical process such as heating or bending the fabric until the binder sub-

stance has been partially loosened. It is noted also that the binder may be removed from one only of two or more paper strips, the whole being united as a single yarn. It should be understood that such loosening may take place to a sufficient extent during the yarn making operation, as, for example, during condensing and twisting steps as brought out more specifically in my co-pending application, Serial No. 684,325 filed of even date with this application. Said application specifically discloses a moistening step followed in order by a step of twisting an asbestos paper-like strip or band with a filament, a condensing step and a final twisting step. While it is not essential herein that the enclosing strip or band be moist in the rubbing operation and in the final twist operation, it is desirable as described in my co-pending application that a certain amount of moisture be present in order to facilitate the smoothing and condensing process and more readily permit an intimate interengagement of the various strands. As stated also in my co-pending application, it has also been found possible to omit moisture entirely, notwithstanding that dry material is not in general so readily worked as wet, and, moreover, is more subject to breakage under some conditions; and where certain types of raw material are employed, as in long-fibred stock, a dry working may be desirable. Such omission of the moistening or loosening of the binding material in the asbestos paper-like material before subjecting the asbestos paper-like material to a condensing or rubbing operation is also disclosed in connection with one form of the process covered by my co-pending application, Serial No. 654,118, filed July 27, 1923.

It will be evident that the moistening operation as effected in the apparatus disclosed herein, while having the effect of softening the binding material and the strip, will ordinarily have very slight effect in dissipating or removing the binding material; and that loosening of the binding material by moistening or, more particularly, by rubbing and bending the paper-like strips or bands may be dispensed with in case the binding material, in the strip or band as manufactured, is sufficiently loose or flexible. Obviously, such strips or bands may be condensed or twisted without preliminary moistening or other loosening of the binding material by merely loosening the paper structure in the strand or yarn making apparatus.

It has been found that yarn made in accordance with the invention as hereinabove described, possesses sufficient flexibility for practically all types of weaving in which the various vegetable fibre yarns are usable, as well as for the ordinary uses in connection with heat insulation, curtaining and various other purposes in which asbestos or mineral fibre is now employed. It may be of value in connection with the yarn and fabrics made in accordance with this process to obtain even greater flexibility by eliminating all material subject to carbonization by high temperature, the fabric being formed entirely of mineral fibre and therefore having great flexibility. In the manufacture of such a fabric formed substantially exclusively of asbestos fibre, use may be made of asbestos yarn from which all combustible material has been removed. In forming such a yarn, the asbestos paper-like material is subjected, prior to its entry into the rubbing mechanism, to sufficient heat to carbonize the starch and entirely free the yarn of all vegetable material. This method has been found to be very efficacious in the complete elimination of the binding material from the asbestos yarn and from fabrics made therefrom.

It is further indicated that, while it may be desirable for some yarns to remove substantially all of the binder incorporated originally in the asbestos paper, it is not essential in all instances, as it has been found, particularly when the fibres are very non-coherent, that a certain percentage of binder remaining in the paper will tend to increase the coherence of the fabric during the rubbing and twisting operation and after the final product has been obtained, the binder remaining in the material, tends to give the same a somewhat greater rigidity than it would otherwise possess. However, too large a percentage of binder will tend to cause breakage in the twisting operation and an undesirable stiffness in the final product.

It should be understood that the term "asbestos material", wherever it appears in the specification and claims, is intended to refer to material having a substantial percentage of asbestos fibres such as to give more or less the characteristics of asbestos as far as working and handling are concerned, and the term "asbestos material" where used in the specification and claims shall be considered as thus defined.

It should be understood that in the event that two strands 9 and 10 are carried over the moistener roller 18 at the same time and rounded by the condenser 14, they will be moistened to substantially the same extent when brought together in the twister. As a result of this condition a greater uniformity of yarn formation can be obtained.

It should also be understood that the term "coreless yarn" wherever it appears in the specification and claims, is intended to refer to a yarn in which there is no reinforce-

ment of the asbestos paper-like material by means such as metallic or non-metallic filaments, threads, and the like.

What is claimed is:

1. The process of making coreless yarn which includes forming a paper-like strip of asbestos material in which the fibres are held together by suitable workable binding material, and forming said strip into a twisted yarn.

2. The process of making coreless yarn which includes forming a paper-like strip of asbestos material in which the fibres are held together by workable binding material, moistening the strip to render the asbestos material and binding material more workable, and forming said strip into a twisted yarn.

3. The process of making coreless yarn which includes forming a paper-like strip of asbestos material in which the fibres are held together by workable binding material, forming the strip into a round strand in which the strip retains its strip formation, and forming a yarn from said strand by twisting the same.

4. In a process of making coreless asbestos yarn, the following steps: forming paper from asbestos material and sufficient workable binding material as to permit slitting the paper; slitting the paper into strips; and shaping and twisting a strip of such paper to form a yarn therefrom.

5. In a process of making coreless asbestos yarn the following steps: forming a pulp containing asbestos material and binding material including a soluble binder; passing the pulp through a paper making machine and forming the finished asbestos paper into a roll; slitting the paper into strips of suitable width; and forming a yarn from one of said strips by treating and shaping.

6. A method of making coreless yarn from fibrous asbestos material, which consists in forming a paper-like strip of the asbestos material with binding material, moistening the binding material within the strip, and forming a yarn from the strip by shaping the same, and permitting the strip binding material to reset.

7. A method of making coreless yarn, which includes forming a paper-like strip of asbestos material, the fibres of which are held together by binding material; moistening the strip to render the binding material more workable; and forming the strip into a yarn by longitudinally advancing, laterally rubbing and twisting the same.

8. A method of making coreless yarn which includes forming a paper strip of asbestos material, the fibres of which are held together by workable binding material, rubbing the strip transversely to form a rounded strand, and twisting said rounded strand.

9. A method of making coreless yarn, which includes forming a paper strip of asbestos material, the fibres of which are held together by binding material in workable condition, forming the strip into a rounded strand without frictional drag resulting therefrom, and twisting the rounded strand.

10. A method of making coreless yarn, which includes forming a substantially dry paper-like strip of asbestos material, the fibres of which are held together by workable binding material, moistening the strip to render it more workable, and forming a yarn from said strip by transverse rubbing and twisting.

11. A method of making coreless yarn, which includes forming a paper strip of asbestos material, the fibres of which are held together by workable binding material, moistening the strip to render it more workable, and passing the strip between longitudinally advancing and laterally compacting devices.

12. A single element asbestos yarn consisting of a strip of finished asbestos paper twisted into yarn shape, the fibres of said twisted strip being held together throughout substantially their entire lengths by oil repellent binding material.

13. An asbestos yarn including a single element strand free from fluffy material to facilitate weaving, consisting of a twisted strip of thin asbestos paper of which the fibres are held together along their lengths by suitable binding material.

14. A coreless asbestos yarn comprising a plurality of strands at least one of which is a single element strand consisting of a twisted strip of thin asbestos paper of which the fibres are held together along their lengths by suitable binding material.

15. The process of making coreless yarn from asbestos paper strips containing a workable binder, which consists in simultaneously and uniformly loosening the binder of two or more asbestos paper strips, simultaneously passing the strips through a rubbing device to shape the same into rounded strands, and finally twisting said strands to form a yarn.

16. The process of making coreless yarn from asbestos paper strips containing a workable binder, which consists in loosening the binder of two or more paper strips, simultaneously passing said strips together in contacting relation through a rubbing device to form a strand, and finally twisting said strand to form a yarn.

17. A method of making coreless asbestos yarn for the manufacture of fabrics and other purposes, which comprises binding and forming asbestos material into a thin uniform paper-like strip or band of sufficient cohesiveness and tenacity to undergo subsequent strand and yarn forming opera-

tions, and thereafter forming said strip or band into a yarn.

18. A method of making coreless asbestos yarn for the manufacture of fabrics and other purposes, which comprises forming asbestos material united with binding material into a thin uniform paper-like strip or band of sufficient cohesiveness and tenacity to undergo subsequent strand and yarn forming operations, and thereafter forming said strip or band into a yarn.

19. A method of making coreless asbestos yarn for the manufacture of fabrics and other purposes, which comprises binding and forming asbestos material into a thin uniform paper-like strip or band of sufficient cohesiveness and tenacity to undergo subsequent strand and yarn forming operations, working said strip or band to form a strand, and then twisting said strand to form a yarn.

20. A method of making coreless asbestos yarn for the manufacture of fabrics and other purposes, which comprises binding and forming asbestos material into a thin moist uniform paper-like strip or band of sufficient cohesiveness and tenacity to undergo subsequent strand and yarn forming operations, anl thereafter forming said moist strip or band into a yarn.

21. A method of making coreless asbestos yarn for the manufacture of fabrics and other purposes, which comprises binding and forming asbestos material into a thin uniform paper-like strip or band of sufficient cohesiveness and tenacity to undergo subsequent strand and yarn forming operations, softening said strip or band, working said softened strip or band to form a strand, and thereafter twisting the strand to form a yarn.

22. A method of making coreless asbestos yarn for the manufacture of fabrics and other purposes, which comprises binding and forming asbestos material into thin uniform paper-like strips or bands of sufficient cohesiveness and tenacity to undergo subsequent strand and yarn forming operations, working said strips or bands to form strands, and thereafter twisting a plurality of strands together to form a yarn.

23. A method of making coreless asbestos yarn for the manufacture of fabrics and other purposes, which comprises binding and forming asbestos material into thin uniform paper-like strips or bands of sufficient cohesiveness and tenacity to undergo subsequent strand and yarn forming operations, moistening said strips or bands, working said moistened strips or bands to form moistened strands, and thereafter twisting a plurality of strands together to form a yarn.

24. A coreless asbestos yarn for the manufacture of fabrics and other purposes formed of thin uniform paper-like strip or band of asbestos material bound together and of sufficient cohesiveness and tenacity to undergo strand and yarn forming operations.

25. A coreless asbestos yarn for the manufacture of fabrics and other purposes formed of thin uniform paper-like strip or band of asbestos material, united with binding material, of sufficient cohesiveness and tenacity to undergo strand and yarn forming operations.

26. A coreless asbestos yarn for the manufacture of fabrics and other purposes formed from thin uniform paper-like strip or band of asbestos material bound together and of sufficient cohesiveness and tenacity to undergo strand and yarn forming operations, said strip or band retaining its strip formation.

27. An asbestos yarn including a single element strand consisting of a twisted strip of thin asbestos paper of which the fibres are held together along their lengths by suitable binding material.

28. A process of making coreless asbestos yarn, which consists in binding and forming asbestos material into a thin uniform paper-like strip or band of sufficient cohesiveness and tenacity to undergo subsequent strand and yarn forming operations, advancing said strip or band, moistening the strip or band as it advances, and forming the advancing strip or band while moist into a twisted yarn.

29. A process of making coreless asbestos yarn, which consists in binding and forming asbestos material into a thin uniform paper-like strip or band of sufficient cohesiveness and tenacity to undergo subsequent strand and yarn forming operations, advancing said strip or band, moistening the strip or band as it advances, forming the advancing strip or band while moist into a round strand, and twisting said rounded strand into a yarn.

30. A process of making coreless asbestos yarn, which consists in binding and forming asbestos material into a thin uniform paper-like strip or band of sufficient cohesiveness and tenacity to undergo subsequent strand and yarn forming operations, advancing said strip or band, moistening the strip or band as it advances, forming said strip or band while moist into a loosely twisted preliminary yarn, and thereafter tightly twisting said preliminary yarn to form a final yarn.

31. A process of making coreless asbestos yarn, which consists in binding and forming asbestos material into thin uniform paper-like strips or bands of sufficient cohesiveness and tenacity to undergo subsequent strand and yarn forming operations, advancing said strips or bands and bringing them to-

Process of making yarn from asbestos paper (US Patent 1,585,617, 1926)
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gether into contacting relation, moistening at least one of the strips or bands as it advances and while in contacting relation, and forming the contacting strips or bands into a twisted yarn.

32. A process of making coreless asbestos yarn, which consists in binding and forming asbestos material into thin uniform paper-like strips or bands of sufficient cohesiveness and tenacity to undergo subsequent strand and yarn forming operations, advancing said strips or bands and bringing them together into contacting relation, moistening at least one of the strips or bands as they advance and while in contacting relation, forming the contacting strips or bands into a rounded strand, and twisting the rounded strand to form a yarn.

33. A process of making coreless asbestos yarn, which consists in binding and forming asbestos material bound into thin uniform paper-like strips or bands of sufficient cohesiveness and tenacity to undergo subsequent strand and yarn forming operations, advancing said strips or bands and bringing them together into contacting relation, moistening at least one of the strips or bands as they advance and while in contacting relation, forming said contacting strips or bands into a loosely twisted preliminary yarn and thereafter tightly twisting the advancing preliminary yarn into a final yarn.

34. In a method of making coreless asbestos yarn for the manufacture of fabrics and other purposes, the steps which consist in binding and forming asbestos material into a thin uniform paper-like strip or band of sufficient cohesiveness and tenacity to undergo subsequent strand forming operations, and forming said strip directly into a single element strand.

35. In a method of making coreless asbestos yarn for the manufacture of fabrics and other purposes, the steps which consists in forming asbestos material united with workable binding material into a thin uniform paper-like strip or band of sufficient cohesiveness and tenacity to undergo subsequent strand forming operations, and forming said strip directly into a single element strand.

36. A coreless asbestos yarn formed of asbestos material present in the yarn in paper-like formation, and bound together with sufficient cohesiveness and tenacity to retain such paper-like formation.

37. A coreless asbestos yarn consisting of asbestos material containing binding material and present in paper-like strip formation.

38. A coreless asbestos yarn consisting of asbestos material bound together with sufficient cohesiveness and tenacity to undergo strand and yarn forming operations and present in paper-like strip formation.

39. A coreless asbestos yarn formed of a plurality of strands each of which consists of asbestos material present in paper-like strip formation one or more of said strands containing binding material.

40. A coreless asbestos yarn for the manufacture of fabrics and other purposes formed of a plurality of thin uniform paper-like strips or bands of asbestos material bound together with sufficient cohesiveness and tenacity to undergo strand and yarn forming operations.

41. A coreless asbestos yarn for the manufacture of fabrics and other purposes formed of a plurality of thin uniform paper-like strips or bands of asbestos material bound together with sufficient cohesiveness and tenacity to undergo strand and yarn forming operations, at least one of said strips containing binding material.

42. A coreless asbestos yarn for the manufacture of fabrics and other purposes comprising a plurality of strands each of which is formed of asbestos paper-like material bound together with sufficient cohesiveness and tenacity to undergo strand and yarn forming operations.

43. A coreless asbestos yarn for the manufacture of fabrics and other purposes comprising a plurality of intertwisted strands each of which is formed of asbestos paper-like material bound together with sufficient cohesiveness and tenacity to undergo strand and yarn forming operations, at least one of said strands containing binding material.

44. A method of making coreless asbestos yarn from strips or bands of asbestos material bound with sufficient cohesiveness and tenacity to undergo subsequent strand and yarn forming operations, which comprises advancing said strips or bands, and thereafter forming a plurality of said strips or bands without tension reinforcement into a yarn.

45. A method of making coreless asbestos yarn from strips or bands of asbestos material bound with sufficient cohesiveness and tenacity and adapted for yarn manufacture, which comprises advancing said strips or bands, and thereafter forming a plurality of said strips or bands without tension reinforcement into a twisted yarn.

46. A method of making coreless asbestos yarn from strips or bands of asbestos material bound with sufficient cohesiveness and tenacity and adapted for yarn manufacture, which comprises forming said strips without tension reinforcement into strands, and thereafter forming a plurality of said strands into a yarn.

47. A method of making coreless asbestos yarn from strips or bands of asbestos material bound with sufficient cohesiveness and tenacity and adapted for yarn manufacture, which comprises forming said strips or bands without tension reinforcement into

strands, and thereafter twisting a plurality of said strands into a yarn.

48. A method of making coreless asbestos yarn from asbestos paper-like material bound with sufficient cohesiveness and tenacity to undergo subsequent mechanical strand and yarn forming operations, which includes mechanically forming said paper-like material without tension reinforcement into strands, and thereafter mechanically forming a plurality of said strands into a yarn.

49. A method of making coreless asbestos yarn from asbestos paper-like material bound with sufficient cohesiveness and tenacity to undergo subsequent mechanical strand and yarn forming operations, which includes mechanically forming said paper-like material without tension reinforcement into strands, and thereafter mechanically forming a plurality of said strands into a twisted yarn.

50. A method of making coreless asbestos yarn from asbestos paper-like material bound with sufficient cohesiveness and tenacity to undergo subsequent mechanical strand and yarn forming operations, which includes moistening said paper-like material, and thereafter mechanically forming said paper-like material without tension reinforcement into a yarn.

51. A method of making coreless asbestos yarn from asbestos paper-like material bound with sufficient cohesiveness and tenacity to undergo subsequent mechanical strand and yarn forming operations, which includes moistening said paper-like material, mechanically forming said paper-like material without tension reinforcement into strands, and thereafter mechanically forming a plurality of said strands into a yarn.

52. A method of making coreless asbestos yarn from asbestos paper-like material bound with sufficient cohesiveness and tenacity to undergo subsequent mechanical strand and yarn forming operations, which comprises mechanically advancing said paper-like material, moistening said paper-like material as it advances, and thereafter mechanically forming the moist paper-like material without tension reinforcement into a yarn.

53. A method of making coreless asbestos yarn from asbestos paper-like material bound with sufficient cohesiveness and tenacity and adapted for yarn manufacture, which comprises mechanically advancing said paper-like material, moistening said paper-like material as it advances, mechanically forming the moist paper-like material into strands, and thereafter mechanically twisting together a plurality of the moist strands to form a multi-strand yarn.

In testimony whereof, I affix my signature.

JOHN ALLEN HEANY.

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