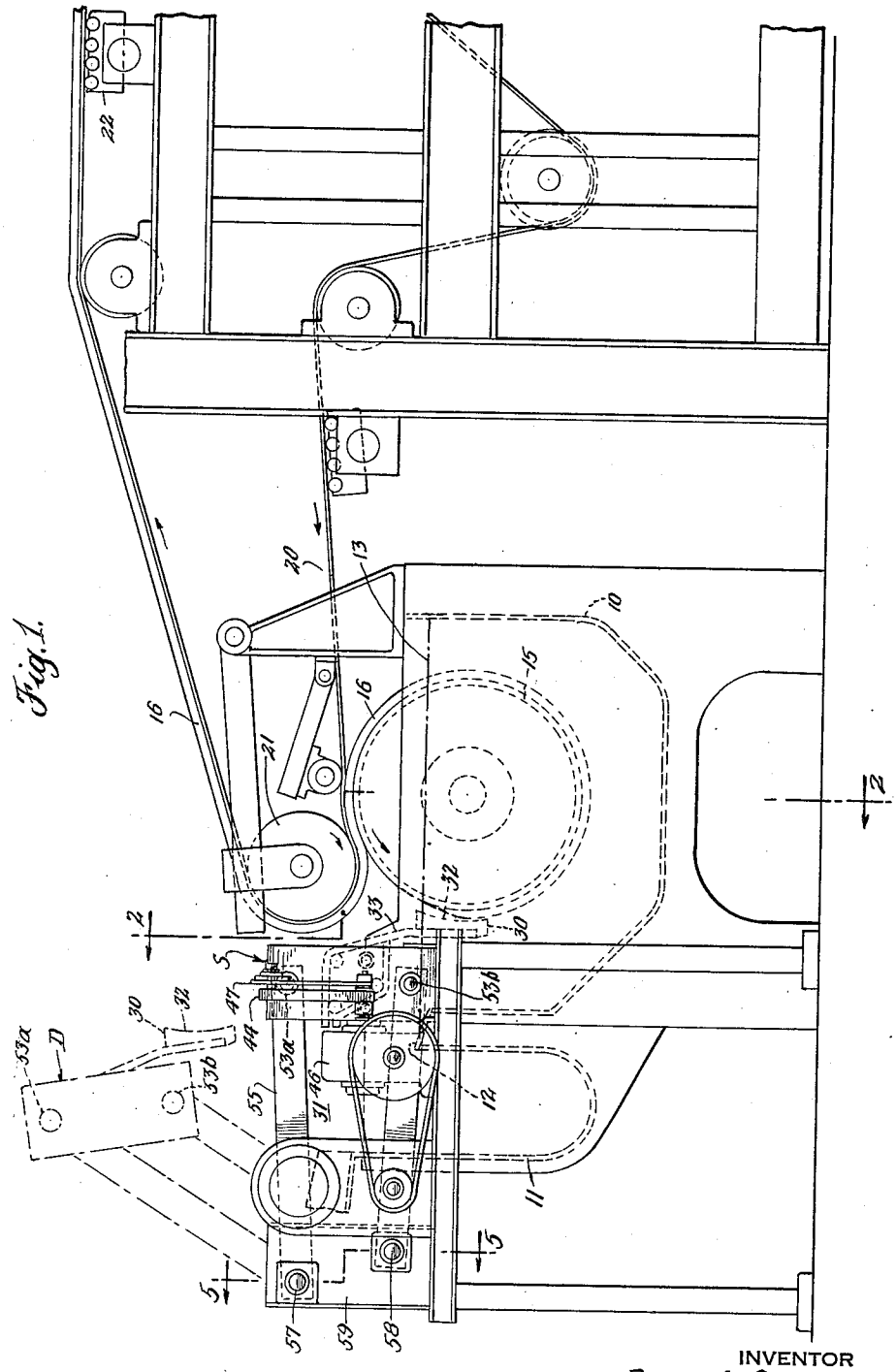
Feb. 4, 1964 R. A. SCHNEIDER 3,120,465

ASBESTOS CEMENT WATER-LAID PRODUCTS CHARACTERIZED BY AN EQUAL LONGITUDINAL TO TRANSVERSE STRENGTH RATIO

Filed Jan. 29, 1960 4 Sheets-Sheet 1

Fig. 1.



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Filed Jan. 29, 1960 4 Sheets-Sheet 2

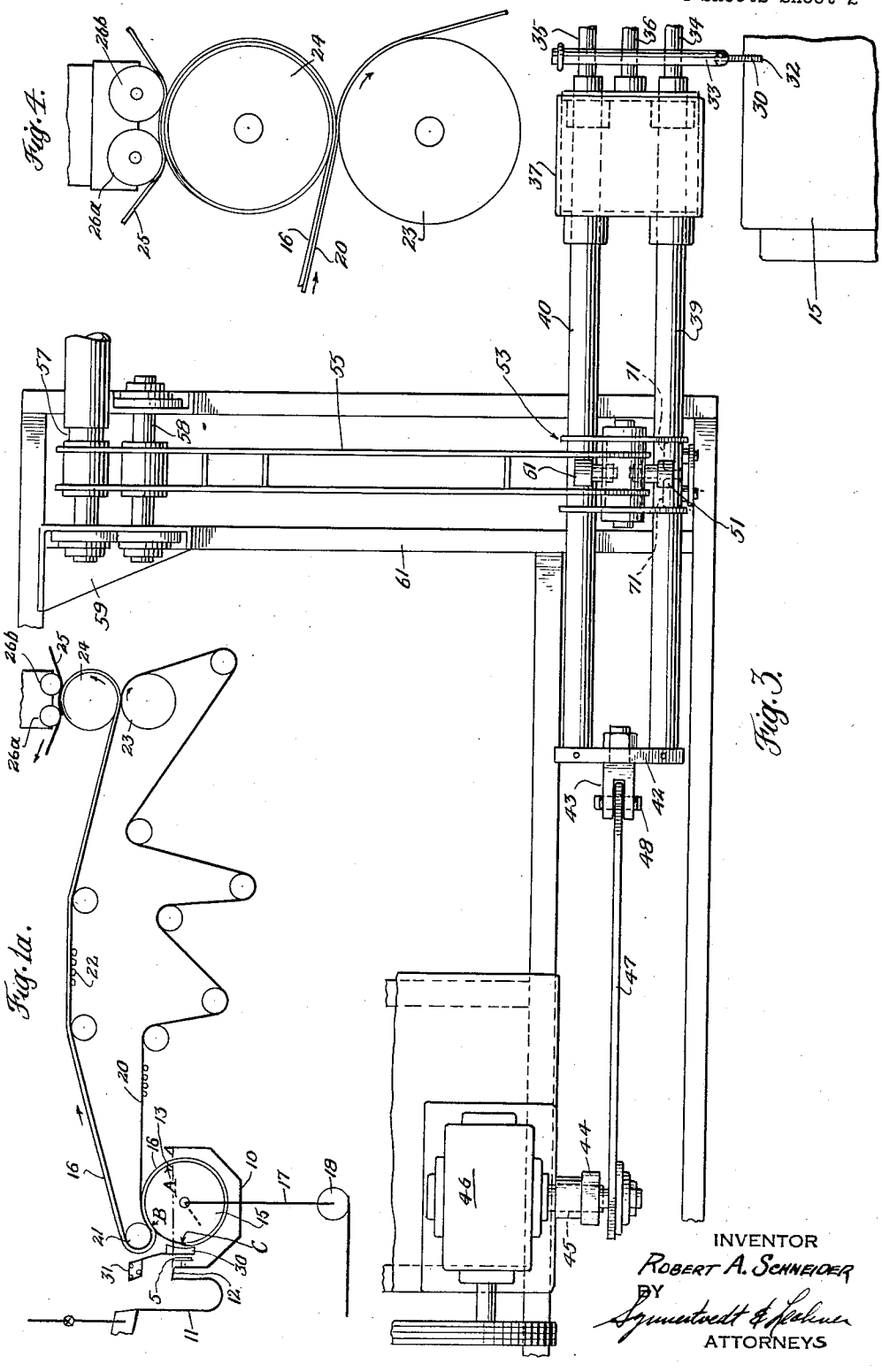


Fig. 1a.

Fig. 3.

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ASBESTOS CEMENT WATER-LAID PRODUCTS CHARACTERIZED BY AN EQUAL LONGITUDINAL TO TRANSVERSE STRENGTH RATIO

Filed Jan. 29, 1960 4 Sheets-Sheet 3

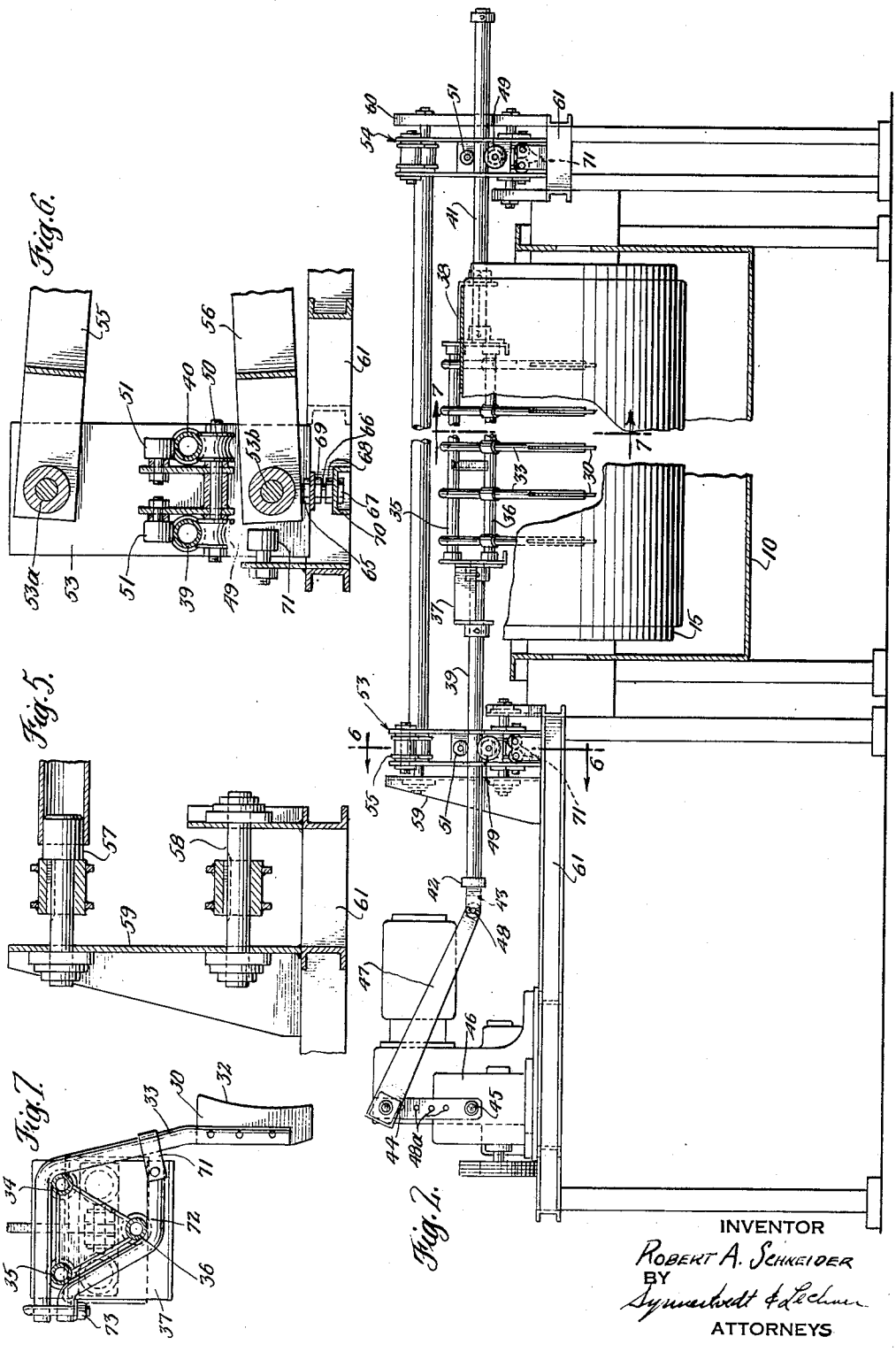


Fig. 1.

Fig. 6.

Fig. 5.

Fig. 7.

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Filed Jan. 29, 1960 4 Sheets-Sheet 4

Fig. 8

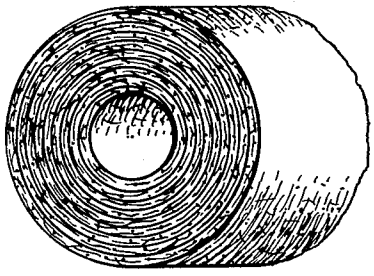


Fig. 9

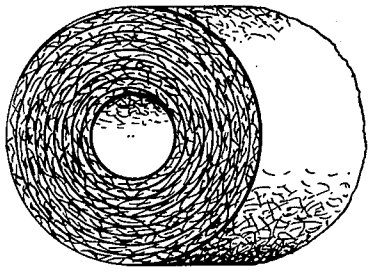


Fig. 10

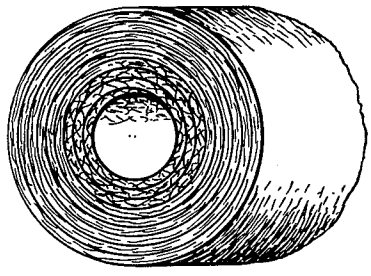


Fig. 11

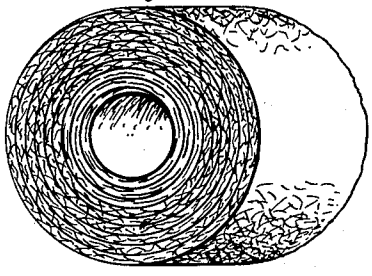


Fig. 12

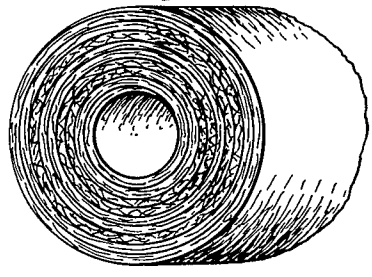
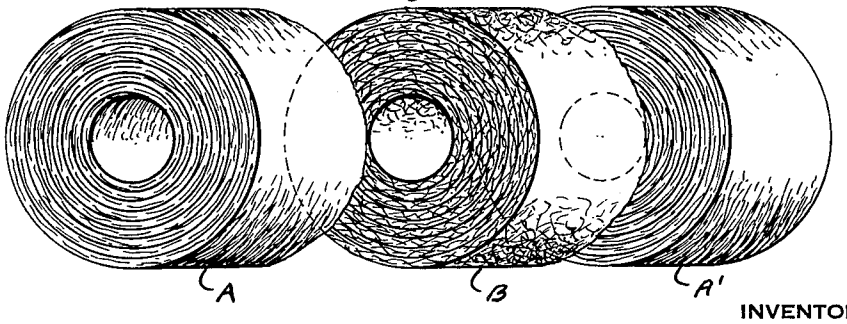


Fig. 13



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ASBESTOS CEMENT WATER-LAID PRODUCTS CHARACTERIZED BY AN EQUAL LONGITUDINAL TO TRANSVERSE STRENGTH RATIO

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Filed Jan. 29, 1960, Ser. No. 5,551
13 Claims. (Cl. 162—118)

This invention relates to the production of fibrous products on cylinder type wet machines, and to the products produced thereon; the invention is particularly concerned with the production of asbestos-cement pipes, asbestos-cement sheets and asbestos paper from cylinder type wet machine formed webs.

In webs produced from asbestos fibers on cylinder type wet machines the fibers are not uniformly randomly oriented; more fibers are aligned generally parallel to the web axis than are aligned generally perpendicular to the web axis. Where the longer types of asbestos fibers are employed for reinforcing purposes the fiber orientation is more pronounced than where the shorter types of asbestos fibers are employed. Nevertheless, even in the case of the shorter types of fibers, there is a pronounced tendency for the fibers to align themselves generally parallel to the lengthwise axis of the web when webs are produced on cylinder type wet machines.

This fiber orientation gives rise to certain objectionable characteristics in the articles such as paper, sheet and pipe made from the webs. For example, the sheet and paper will have a "grain" and will exhibit strikingly different strength characteristics depending on whether it is subjected to stresses in directions lengthwise or across the grain. Pipe made from webs having this conventional type of fiber orientation will exhibit good strength against bursting forces because the fibers will be aligned circumferentially of the pipe axis but the pipe has poor strength characteristics with respect to flexing forces.

Further in connection with pipe made from asbestos cement webs formed on cylinder type wet machines, previous efforts to improve the flex strength have involved such steps as increasing the wall thickness, changing the formulation to increase the fiber content, etc.

Increasing the wall thickness has obvious disadvantages in that the weight of the pipe is also greatly increased and fewer pipes can be made from a given quantity of raw material.

Changing the formulation to build in additional flex strength necessitates significantly increasing the fiber content or fiber reinforcing value of the furnish. The asbestos fibers are by far the most expensive (on a pound for pound basis) raw material used in making the asbestos-cement pipe, and in order to produce asbestos-cement pipe which will meet minimum industry established standards, from about 15% to 20% of the weight of the pipe is asbestos depending on the class of pipe being produced.

I have discovered that it is possible to vary and control the degree and type of fiber orientation of webs produced on cylinder type wet machines and in this way I can modify the strength characteristics of articles formed from the web, and this can be done without changing the formulation of the furnish.

By utilizing the techniques and equipment of this invention, it is possible to randomly orient a considerably greater percentage of the fibers. It is also possible to produce webs in which the greatest percentage of the fibers are aligned in directions other than generally parallel to the direction of web travel or web axis.

I accomplish the fiber reorientation by imparting sufficient movement to the slurry solids (in the zone adjacent to the mold cylinder where the major portion of the slurry

solids accumulate on the cylinder) to overcome the fiber aligning tendencies of the rotating cylinder mold.

By utilizing this new fiber orientation technique I have been able to reorient the fibers to such an extent that it is possible to significantly enhance the flex strength of pipe without adversely influencing the bursting strength and without changing the formulation. The new fiber orientation technique also enables the production of asbestos-cement pipe having strength characteristics comparable to those in conventional production, but in which formulations are used which could not previously be employed to produce acceptable pipe. From a cost standpoint the saving in raw material is as much as 10%–20%.

The technique and apparatus of the invention also enable production of laminated asbestos-cement sheets and asbestos papers in which the ratio of the longitudinal strength to the transverse strength is almost 1/1. Sheet and paper produced without employing the fiber orienting technique and apparatus of this invention exhibit longitudinal transverse strength ratios of from 1.5/1 to 4/1.

Accordingly, it is one of the objects of this invention to provide a method and apparatus for varying and controlling the orientation of the fibers of webs being formed on cylinder type wet machines and in articles produced therefrom.

It is another object of this invention to impart to articles particularly asbestos fiber products, such as papers, sheets and pipes made from webs formed on cylinder-type wet machines, strength characteristics which heretofore were unobtainable when such articles having the same size and shape and made from the same formulation were produced from webs formed in a conventional manner on such machines.

It is still another object of this invention to provide as new and novel articles of manufacture, namely, asbestos paper, asbestos-cement sheet, and asbestos-cement pipe which have novel and unique strength characteristics.

Other objectives and advantages of my invention will be developed in the drawings, in the ensuing discussion and in the examples which illustrate in greater detail the features of my invention.

Accordingly, the method aspects of this invention for producing webs on a cylinder-type wet machine in which the fibers are randomly oriented are accomplished by imparting movement (in a direction generally parallel to the mold's axis of rotation) to the slurry solids in the sector adjacent to the cylinder mold surface as it moves downwardly into the slurry.

Also according to the invention, the apparatus for obtaining the desired objectives comprises, in combination with a conventional wet machine, one or more vanes (liner blades) positioned in a plane intersecting the cylinder mold axis and adjacent the portion of the periphery of the cylinder mold below the level of the slurry at the side of the mold cylinder moving downwardly into the vat, and means for imparting reciprocating movement to the vane or vanes in a path generally parallel to the axis of rotation of the cylinder mold.

Further, in accordance with the product aspects of this invention, the invention objectives are achieved in cylinder type wet-machine formed asbestos-cement pipe which is characterized in that predetermined portions of the asbestos fibers are controllably oriented. Wet machine formed asbestos-cement sheets and asbestos paper which is substantially free of grain and wherein the fibers are generally randomly oriented in the plane of sheet constitute still other aspects of this invention.

The process and apparatus aspects of this invention can be seen in the accompanying drawings in which:

FIG. 1 is a detailed elevational view (looking toward the right in FIG. 2) of a conventional cylinder type wet

machine used for forming the fibrous webs and which has been provided with the liner mechanism of this invention.

FIG. 1*a* is a schematic illustration of some of the major elements of such a wet machine and shows the production of pipe from webs produced on the wet machine.

FIG. 2 is a broken out cross section on line 2—2 of FIG. 1 with the mold vat and mold cylinder shown diagrammatically.

FIG. 3 is an enlarged fragmentary plan view of part of the equipment shown in FIG. 2.

FIG. 4 is a diagrammatic elevational view of some of the major elements used in a machine for forming pipes from the web.

FIG. 5 is a sectional view along line 5—5 of FIG. 1.

FIG. 6 is a sectional view on the line 6—6 of FIG. 2.

FIG. 7 is a sectional view along the line 7—7 of FIG. 2.

FIG. 8 is an isometric end view of a section of pipe produced on a conventional wet machine; and

FIGS. 9 through 12 are similar isometric end views of sections of pipe made according to the present invention and FIGURE 13 is an isometric view of three different sections of a pipe made in accordance with the present invention.

In FIGURES 8 through 13 details regarding fiber alignment and layer boundaries are emphasized to illustrate details of the invention.

In a typical wet machine as shown in the drawings, there is a molding vat 10. A fibrous slurry or furnish is fed into the feed box 11, passes over the weir 12 and into the molding vat where it is maintained at a substantially constant level 13.

A cylinder mold 15 is positioned in the molding vat and partially submerged in the slurry to a depth of about ⅓ to ⅔ its diameter; in most instances only between about 180°–220° of the mold's circumference is submerged. The cylinder mold is adopted to rotate about its longitudinal axis so as to move the surface into and out of the slurry. In most cases the surface of the cylinder mold is perforated—usually a screen sieve. However, in some modified forms of wet machines, an imperforate cylinder mold is used. With perforated sieve or screen type molds, the screen acts as a filter cloth, water passes through the perforations and a layer 16 of the slurry solids gathers and accumulates on the surface of the rotating drum. In such cases, the cylinder mold is provided with means (schematically shown at 17, 18) for removing the water inside the drum from which slurry solids have been removed to prevent undue dilution of the furnish. Frequently, the water removed in this operation contains some small fibers and it can be recycled to a slurry make-up tank where additional material is added thereto to build up a slurry of the desired formulation.

As the rotating cylinder mold moves out of the slurry vat at point (A) (FIG. 1*a*) it is carrying on its surface a layer of fibers 16. At point (B) (FIG. 1*a*), the accumulated fibers are transferred to a continuous felt conveyor belt 20, which is travelling at the same speed and in the same direction as the cylinder is rotating. The felt 20 is maintained in engagement with the mold cylinder 15 by means of the couch roll 21 which also acts to assist the transfer of the fibers from the mold to the felt. In this operation the fibers are deposited on the felt as a continuous moist web which is further dewatered, as for example by slot extractors 22. After the fibrous web is sufficiently dewatered it can be processed into sheet, pipes and the like in a known manner.

In FIG. 1*a*, I have schematically illustrated a pipe forming apparatus being used in conjunction with the wet machine. The basic elements of such pipe machines include an anvil roll 23 over which the felt 20 carrying the fibrous web 16 is fed, a mandrel 24 is positioned above the anvil roll and rotates in the same direction as the felt. As the fibrous web 16 passes the nip between the anvil and mandrel, the web is transferred to the mandrel and builds up thereon in convolute layers until a pipe of the desired wall thickness has been formed. To assist in forming the pipe and to express water and compact the pipe, a top felt 25 is held against the material being built up on the mandrel by press rolls 26*a* and 26*b*.

When asbestos-cement webs are produced on wet machines, such as that shown in FIG. 1*a*, the asbestos fibers, especially the longer ones, have a very strong tendency to align themselves with their longer axes generally parallel to one another and generally parallel to the direction of the mold cylinder's rotative path. Therefore, the asbestos fibers in the pipe formed by the webs will exhibit a high degree of orientation or alignment. They will be disposed generally parallel to one another with their longitudinal axes aligned circumferentially around the pipe axis as illustratively shown in FIGURE 8.

According to my invention, this general pattern of fiber alignment can be modified so as to provide for controllable random orientation of the asbestos fibers. The means by which I can effect this random orientation are schematically shown in FIG. 1*a*, as the so-called "liner" 30 and the associated means 31 for imparting a reciprocating movement to the liner (and also to the solids contacting the liner) in directions generally parallel to the cylinder mold axis.

FIGS. 1–3 and 5–7 illustrate a preferred manner of mounting and operating the liner mechanism so as to provide for a very wide degree of control and flexibility, as to the type of fiber re-alignment, the degree of re-orientation and to enable the reorientation to be confined to certain specific areas of the web or to cover the full width of the web, thus permitting the characteristics of the end product—be it in sheet or pipe form—to be varied and controlled as desired. By illustrating the invention in this way, it is not intended to limit the invention to the particular form as shown. Variations thereof which enable the desired objective to be achieved are deemed to fall within the scope of the invention.

Referring to FIG. 1, the liner assembly is shown in two positions; the solid line illustration (S) showing the liner in its operating position, and the dot-dash illustration (D) showing the liner swung out to an inoperative position. Suitable counterbalances can be employed, if desired, to facilitate the swing out and to hold the liner mechanism in any desired position.

The liner 30, shown in FIG. 1 is in the form of a vane or thin blade, and the inner edge 32, which is presented toward the mold cylinder, is preferably contoured to conform to the mold cylinder surface. I also prefer to have the plane of the blade perpendicular to the mold cylinder axis but the desired objectives can also be achieved if the blade is angled sufficiently so that its projected plane will intersect the cylinder axis.

The liner blade 30, when the liner assembly is in position (S) (FIG. 1), is adapted to be moved in a reciprocating path across the surface of the cylinder mold and generally parallel to the cylinder mold's axis of rotation. The inner edge 32 is offset from the mold surface a distance which will prevent the moving blade from contacting the fibrous layer being gathered on the surface of the cylinder, i.e., about ¼" to 2" therefrom.

As shown in FIG. 7, the blade 30 is carried by an arm 33 which in turn is adjustably mounted by means of clamp 71, arm 72, and bolt 73 to a frame assembly including three rods 34, 35 and 36 positioned to form a triangular prism. End members 37 and 38 (FIG. 1) hold rods 34, 35 and 36 in relative disposition shown in FIG. 7.

As can be best seen in FIG. 3, a pair of slide bars 39 and 40 are affixed to end member 37 and extend outwardly from the end member in a direction opposite to but aligned with rods 34, 35 and 36. A similar pair of slide bars are affixed to and project outwardly from end member 38. One of these slide bars 41 can be seen in FIG. 2. The ends of the slide bars 39 and 40 which are not attached to end member 37 are connected by an end

piece 42 which carries a yoke 43. The elements 34–43 comprise the liner frame assembly and the various rods and bars forming this assembly are aligned parallel to a common axis which is parallel to the axis of the cylinder mold.

Referring now to FIGS. 2 and 3, the frame assembly is given reciprocating movement by a crank 44, attached to the shaft 45 of a suitably driven gear box 46. A connecting rod 47 extends between the crank and the frame assembly. The connecting rod 47 and yoke 43 are pivoted on a pin 48, in a manner which will permit the rod to oscillate on the pin as the crank rotates and reciprocate the liner frame in a path parallel to the mold cylinder axis. To enable the length of the stroke to be controlled, the crank is provided with a series of holes 48*a*, positioned at various intervals which facilitate attaching the connecting rod to the crank at various positions offset from the center of rotation.

As is shown in FIGS. 2 and 6, the slide bars 39 and 40 ride on a pair of roller guides 49 and 50. The pair of slide bars at the opposite end of the frame assembly ride in a similar pair of roller guides. To insure constant and proper tracking, each roller guide acts in conjunction with a guide wheel 51. The slide bar 39 is maintained in the groove of roller 49 by the co-action of wheel 51 on the upper surface of the slide bar.

The roller guides are in turn carried on a "swing out" frame assembly which permits the liner frame assembly to be moved into and out of operating position. In these operations, rollers 71 serve as guides for aligning and positioning the carrier units.

The swing out assembly includes a pair of carrier units 53 and 54, each of which provide the mounting supports for the roller guides. One such unit is positioned at each end of the liner frame assembly. Each of the carrier units is pivoted, 53*a*, 53*b* at the top and bottom of the unit on a pair of arms 55 and 56. The trailing ends of each of the arms 55 and 56 are pivoted at 57 and 58 to fixed supports 59 and 60 which are secured to the supporting frame structure 61. The pivot points 57 and 58 are not in vertical alignment (see FIG. 1), the pivot points 57 and 53*a* providing for rotation about a longer radius than is formed by the lower arm affixed to pivot points 58 and 53*b*. This arrangement facilitates retraction and positioning of the contoured liners without interfering with fiber accumulated on the cylinder.

To swing the liner frame assembly from its operating position (S) to an inoperative position such as position (D), the connecting rod 47 must be disconnected from either the crank 44, or the yoke 43, and the entire assembly including the liner frame assembly, the liner blades, and the carrier units can be shifted between positions (S) and (D).

In operating the liner mechanism, I usually employ a plurality of liner blades spaced along the liner frame at intervals which will provide for the desired type and degree of fiber reorientation as this permits the stroke to be short and also shortening the cycle of oscillation. However, for many purposes a single vane will suffice.

The liner blades or vanes are positioned in the slurry vat adjacent the point where the clean mold cylinder surface moves into the slurry (position (C), FIG. 1*a*) and the contoured blade edge 32, which is presented toward the mold cylinder surface is to be submerged in the slurry to a depth whereby the blade edge will oscillate over the sector of the mold cylinder surface in which the majority of pick-up of solids on the mold occurs.

In the usual operation of wet machines between about 180°–220° of the mold's circumference is submerged in the slurry and the majority of the fiber pick-up or accumulation occurs in the sector immediately following the entrance of the clean mold surface into the slurry. In the first 30° to 40° of submerged rotation, the mold will gather approximately 75% of the total materials which will be accumulated thereon as the mold rotates through the vat over 50% accumulation will generally be effected in the first 15° of submerged rotation.

As can be seen in FIGS. 7 and 6, the submergence of the liner blade can be adjusted in either of two ways to provide for covering the prescribed sector. In FIG. 7, the arm 33 is forked at the end carrying the blade 30 and a series of spaced bolt holes enable the blade 30 to set in various positions to provide for the desired degree of blade submergence. As is shown in FIG. 6, the bottom of the carrier unit 53 rests on a stop 65, when the unit is in position (A) (FIG. 1) the stop can be variably positioned relative to the frame 61, by suitably adjusting the shimming device (bolt 66, attached to the arresting plate 65, and nuts 67, 68 and 69 and the frame extension 70).

In order to establish a quiescent zone in the sector in which the solids pick-up is the greatest, it is customary to provide a submerged baffle, 5 (FIG. 1*a*) which is positioned in the mold vat intermediate the fresh slurry supply and the mold cylinder. In such cases, the liner mechanism is positioned to operate in the quiescent zone, i.e., intermediate the baffle and the cylinder as shown in FIG. 1*a*.

The agitative movement given to the slurry solids by reciprocating the liner should not be sufficient to cause turbulence in the quiescent zone adjacent the mold surface which will produce a web of non-uniform thickness. The agitative movement should be sufficient to overcome the tendency of the rotating drum to cause a substantial portion of the fibers to align themselves generally parallel to one another and with their longitudinal axes pointing in the path of rotation.

With an arrangement employing a 13′ (long) wet cylinder and having 5 to 12 vanes and with the blade edges offset from the cylinder surface from about ¼″ to 1″, turbulence is not created when the liner frame is reciprocated with a 6″–24″ stroke in cycles ranging from ½ to 5 seconds. Such operating conditions will permit reorientation of a substantial portion of the fibers (for example as illustrated in FIGURE 9) in processing operations where it is desired to produce pipe having good hydrostatic or bursting strength and exceptional flex strength. The amount of reorientation will depend on various factors including the average length of the fibers, their harshness, the water/solids ratio of the slurry, the speed of the liner, the thickness of the web to be formed, etc.

The extent to which fiber reorientation will occur is also related to the distance at which the liner vanes are offset from the cylinder mold and to the relative speeds at which the liner and the felt are operated. For a given offset spacing and if the liner speed is held constant, increasing the felt speed will tend to increase the tendency of the fibers to be aligned generally parallel to the web axis, while decreasing the felt speed will tend to decrease the tendency for the fibers to be aligned generally parallel to the web axis. With liner vanes offset about ¼″ to 1″ from the mold face and where the felt speed is approximately 1.7 to 2 times the average liner speed, webs can be produced which have a highly desirable type of fiber orientation. Asbestos-cement pipe made from webs formed in this way are characterized by significantly enhanced flex strength and the hydrostatic strength is relatively unchanged.

In certain applications, for example, in the production of sewer pipe, the hydrostatic or bursting strength of the pipe is of little moment. In such cases, the equipment can be operated in a way which will permit the production of webs in which a substantial portion of the fibers are oriented generally parallel to the pipe axis, for example, shortening the reciprocating cycle as aforesaid. The pipe made therefrom will have a very high flex strength but its hydrostatic strength will be of a relatively low value.

The vanes can be positioned on the liner frame assem-

bly in various ways so as to influence the fiber alignment in specific areas across the web or to cause reorientation to occur uniformly across the entire width of the web. where it is desired to effect reorientation throughout the full length of mold cylinder (i.e., full width of the web) the outermost vanes should be positioned at distances which insure that some lateral movement will be imparted to the slurry solids adjacent the ends of the cylinder, and the intermediate vanes can be equidistantly spaced from one another.

Where it is desired to confine reorientation effect to a given area, for example, it is frequently desired to make pipe in which the randomly oriented fibers are concentrated in a given area which can be expected to be subjected to severe flexing forces and have circumferential fiber alignment in the other areas. This can be accomplished by adjusting the length of the stroke and positioning the vanes so as to provide for full width coverage of the area in which it is desired to effect the fiber realignment. Where the zone to be randomly oriented is a greater width than can be effectively traversed by one oscillation of a single vane, a plurality of vanes can be so positioned on the liner frame assembly to provide for full coverage in a single cycle of the area to be realigned.

A very desirable type of asbestos-cement pipe (generally illustrated in FIGURE 13) can be produced by randomly orienting a substantial portion of the fibers in the barrel portion (13) intermediate the pipe ends (A and A') and allowing the fibers in the pipe end portions to be aligned generally circumferentially of the pipe axis.

Operating in this way is especially desirable where the pipe ends are to be machined down to form a smooth closely dimensioned coupling joint. The machining necessary thins out the pipe wall and this in turn reduces the strength, especially the bursting strengths in the machined areas. Hence it is desirable to have the fibers in the areas to be machined aligned circumferentially so as to maximize the burst strength values at these points. The circumferential fiber alignment desirably should extend somewhat beyond the area to be machined, generally extending inboard about 4" to 6" beyond the area to be machined.

Another highly desirable type of asbestos-cement pipe (illustratively shown in FIGURE 11) which can be produced on the machine operated in accordance with this invention is one in which the fibers in the inner portions of the pipe wall are predominantly circumferentially aligned and those in the outer pipe wall are predominantly randomly aligned. Such pipe is produced by first forming a web in a conventional manner, i.e., without actuating the liner mechanism. In this operation the liner assembly can be in position (S) (FIG. 1) and with the vanes immobilized or reciprocating very slowly so as not to effect an appreciable degree of reorientation. After a length of webbing sufficient to provide a wall of the desired thickness in which the fibers are circumferentially aligned has been formed by the wet machine, the liner mechanism is then actuated to randomly orient the fibers in the portion of the web which will be used to form the outer layers of the pipe wall. In most cases significant enhancement of flex strength is obtained if the last approximately 20% of the webbing used to form the pipe have the fibers generally randomly oriented, or if the fibers are aligned predominantly parallel to the pipe axis. Substantial flex strength enhancement will be obtained if over ¼ of the wall thickness is formed from webs in which the fibers have been given a predominantly random orientation.

This sequence of operations can also be reversed (as illustratively shown in FIGURE 10) to vary the characteristics of the finished pipe and unique strength characteristics can also be imparted if the pipe is formed of alternating layers (illustratively shown in FIGURE 12) composed of one or more web thicknesses of predominantly randomly oriented fibers and of predominantly circumferential aligned fibers. The latter type pipe is produced by intermittent operation of the liner during the formation of the web which is used to form the pipe.

The following examples will show how the invention may be carried out and also serve to illustrate some of the benefits obtained by the invention.

EXAMPLE I

Using a conventional furnish containing 15% asbestos fiber, a wet machine having a 34" diameter cylinder mold was operated in a conventional manner to form 13-foot lengths of 6" (I.D.) Class 150 (Federal Specification No. SS–P–351*a*) pressure pipe and the pipe then autoclaved.

These pipes were tested for burst and flexural strengths using industry approved test procedures. The average of the test results appears in Table 1, line 1.

EXAMPLE II

Example I was repeated using a furnish containing 17½% asbestos fibers.

The average of test results appears in Table 1, line 2.

EXAMPLE III

Example I was repeated but the liner mechanism was in position (S) and was operated with the liner blades spaced at about 12" intervals. The liner operated with a stroke of about 24" and traversed the central 9-feet of the 13-foot web. The felt speed was 1.73 times the average liner speed.

The average of the test results appears in Table 1, line 3.

EXAMPLE IV

Example III was repeated using the furnish employed in Example II.

The average of the test results appears in Table 1, line 4.

Table 1

Ex.	Asbestos in Furnish percent	P. s. i. Bursting Strength	Lbs. Flexural Strength
1	15	690	2,800
2	17½	740	2,920
3	15	680	3,130
4	17½	730	3,320
Federal Spec. No. SS–P–351a Industry Standard (Minimum)		525	2,800

As can be seen from a comparison of the data reported in Table 1, the flexural strength of the linered pipe (Ex. 3 and 4) is significantly enhanced, without any appreciable effect on the bursting strength.

The liner mechanism is also useful in the production of sheet materials such as asbestos paper and laminated asbestos cement sheets.

Asbestos papers produced on a conventional wet machine are characterized by longitudinal/transverse strength ratios of the order of 1.5/1 to 2/1 and frequently go as high as 4/1. By employing the liner mechanism, however, it is possible to produce asbestos paper from wet machine formed webs where the longitudinal/transverse strength ratio is less than 1.5/1 and approaches 1/1.

I claim:

1. In a process of forming asbestos-cement pipe involving forming an asbestos-cement web on cylinder type wet machine and wrapping convolute layers of the web about a mandrel until a pipe of the desired wall thickness has been formed, the method of improving the flexure strength of the pipe which comprises, in the first wrap-up stages to form the inner pipe layers, wrapping an asbestos cement web in which the longitudinal fiber axes are predominantly oriented generally parallel to one another and aligned generally parallel to the longitudinal web axis, and in the final wrap-up stages, forming the outer pipe

layers, wrapping an asbestos cement web in which the fibers are generally randomly oriented with respect to the longitudinal web axis.

2. Method according to claim 1 wherein the web from which the pipe is formed is a single continuous web in which the fibers in the leading end of the web are used to form the inner wall layers of the pipe, aligned generally parallel to the web axis, and the fibers in the trailing end of the web used to form the outer layers of the pipe are randomly oriented with respect to the pipe axis.

3. In a process of forming asbestos cement pipe involving forming an asbestos cement web on a cylinder type wet machine and wrapping convolute layers of the web about a mandrel until a pipe of the desired wall thickness has been formed, the method of improving the flexure strength of the pipe which comprises decreasing the quantity of fibers having their longitudinal axes presented generally lengthwise and parallel to the web axis and increasing the quantity of fibers which are randomly oriented with respect to the web axis by agitating the slurry solids, in the zone adjacent the sector of the mold cylinder at which the majority of the fiber accumulation occurs, said agitation being sufficient to overcome the fiber aligning tendency of the rotating cylinder mold without inducing a turbulent condition in the agitated zone.

4. In a process for forming asbestos-cement pipe involving forming an asbestos cement web on a cylinder type wet machine and wrapping convolute layers of the web about a mandrel until a pipe of the desired wall thickness has been formed, the method which comprises, in the first wrap-up stages to form the inner pipe layers, wrapping an asbestos cement web in which the asbestos fibers are generally randomly oriented with respect to the longitudinal web axis, and in the final wrap-up stages, forming the outer pipe layers, wrapping an asbestos cement web in which the longitudinal fiber axes are predominantly oriented generally parallel to one another and aligned generally parallel to the longitudinal web axis.

5. In a process of forming asbestos cement webs involving flowing an asbestos cement slurry into a mold vat provided with a mold cylinder adapted to rotate about the cylinder axis and move into and out of the slurry, gathering slurry solids on the mold surface as said surface enters and passes through the slurry contained in the vat, and transferring the collected slurry solids from the cylinder to a moving belt at a point above the surface of the slurry, the method of randomly aligning the asbestos fibers being gathered on the mold surface which comprises, agitating the slurry solids in the zone adjacent the sector of the mold cylinder at which the majority of the fiber accumulation occurs, said agitation being sufficient to overcome the fiber aligning tendency of the rotating cylinder mold without inducing a turbulent condition in the agitated zone.

6. Asbestos-cement pipe characterized in that a predominant portion of the asbestos fibers in the wall adjacent the outer periphery are oriented with their longitudinal axes extending generally circumferentially of the longitudinal pipe axis; and wherein the fibers in the layers adjacent the inner periphery of the pipe are randomly oriented.

7. Asbestos-cement pipe characterized in that the fibers in wall sections adjacent the pipe ends are aligned with their longitudinal axes presented generally circumferentially of the pipe axis and the fibers in the wall of the intermediate pipe-barrel portion are generally randomly oriented.

8. Asbestos-cement pipe characterized in that a predominant portion of the asbestos fibers in the wall adjacent the inner periphery are oriented with their longitudinal axis extending generally circumferentially of the longitudinal pipe axis; and wherein the fibers in the layers adjacent the outer periphery of the pipe are randomly oriented.

9. Asbestos cement pipe formed of convolutely wrapped layers of an asbestos cement web characterized in that alternating layers of at least one web thickness are formed of predominantly randomly oriented fibers on the one hand and of predominantly circumferentially lined fibers on the other hand.

10. A cylinder-type wet machine formed asbestos-cement web characterized in that the asbestos fibers are generally randomly oriented and in that for a given web thickness the ratio of the longitudinal machine direction strength to the tranverse strength is about 1/1 to 1.5/1.

11. Asbestos cement pipe formed of a plurality of convolutely wrapped layers of a cylinder-type wet machine formed asbestos-cement web characterized in that the major portion of the asbestos fibers in a given web thickness are generally randomly oriented relative to one another and to the pipe axis and in that for a given web thickness the ratio of the longitudinal machine direction strength to the transverse strength is about 1/1 to 1.5/1.

12. Cylinder-type wet machine formed asbestos paper characterized in that for a given web thickness the asbestos fibers are generally randomly oriented such that the longitudinal machine direction strength to the transverse strength is about 1/1 to 1.5/1.

13. Asbestos cement products produced from cylinder-type wet machine formed asbestos-cement webs in which the asbestos fibers of a given web thickness are generally randomly oriented relative to one another and the ratio of longitudinal machine direction strength to the transverse strength is about 1/1 to 1.5/1.

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