L. A. SUBERS.

FIRE HOSE AND ANALOGOUS TUBING CONSTRUCTED OF LAMINATED COHESIVE INTERWOUND MEMBERS HAVING VARYING LIMITS OF ELASTICITY.

APPLICATION FILED OCT. 17, 1910.

1,011,090. Patented Dec. 5, 1911.

7 SHEETS—SHEET 1.

FIG. 1

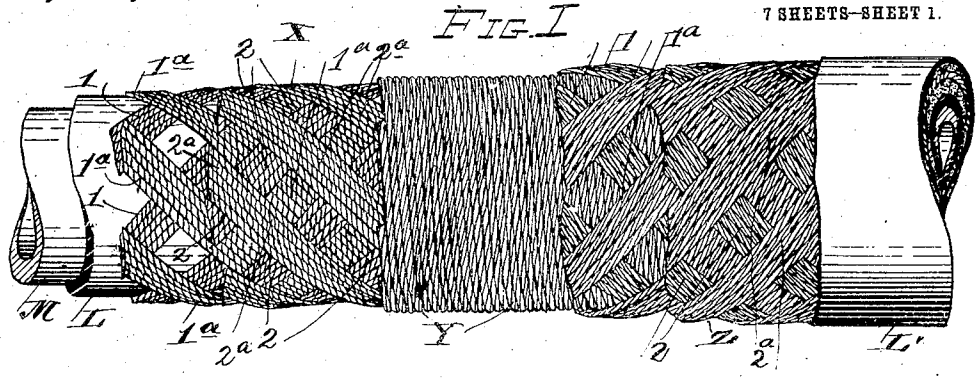


FIG. 2

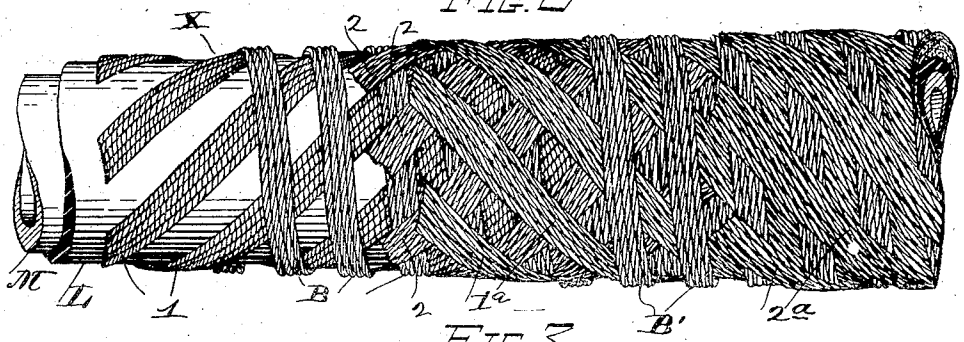


FIG. 3

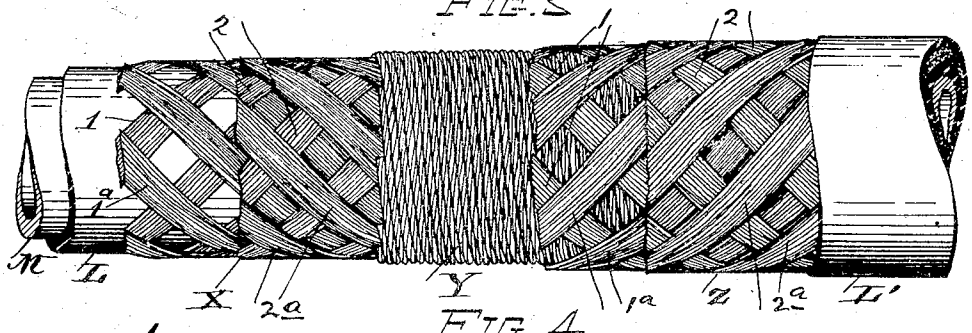
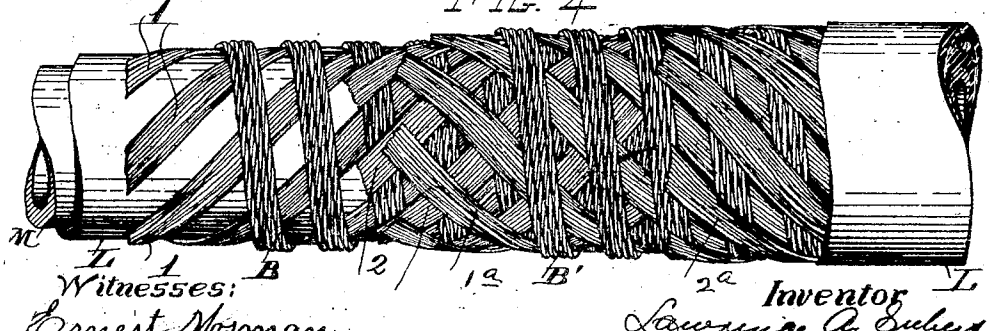


FIG. 4



Witnesses:
Ernest Norman
B. [illegible]

Inventor
Lawrence A. Subers
By Wm. M. [illegible]
Attorney

L. A. SUBERS.

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7 SHEETS—SHEET 2.

FIG. 5

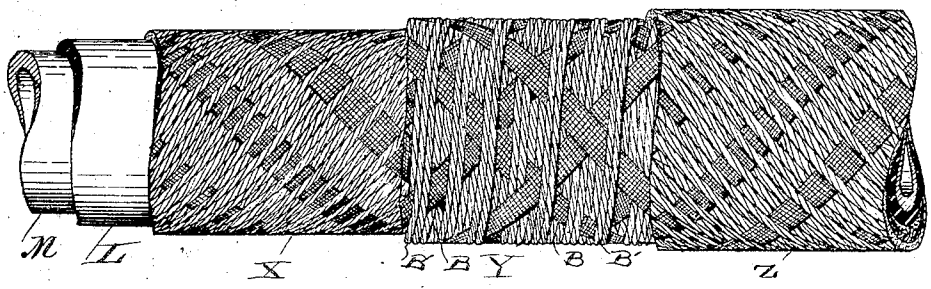


FIG. 6

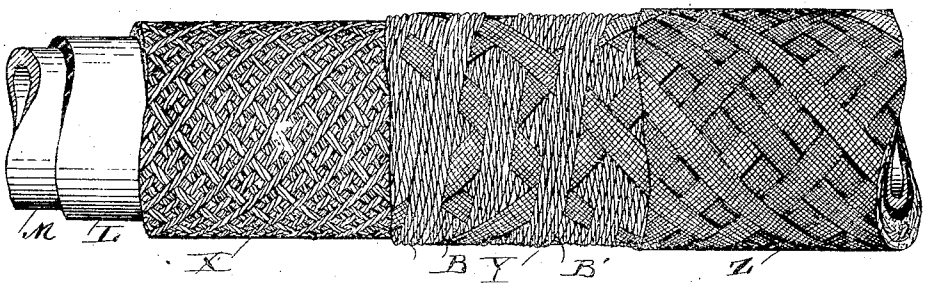


FIG. 7

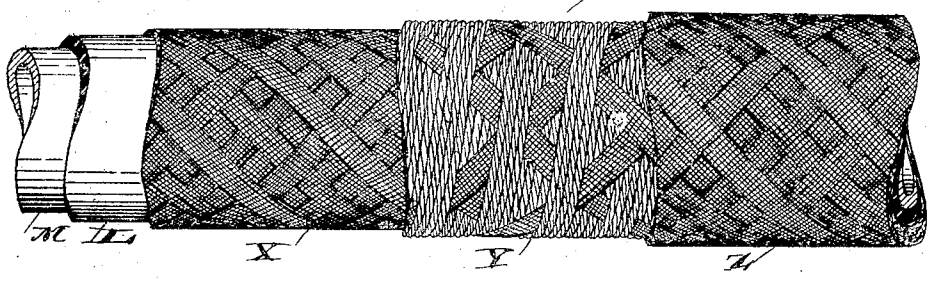
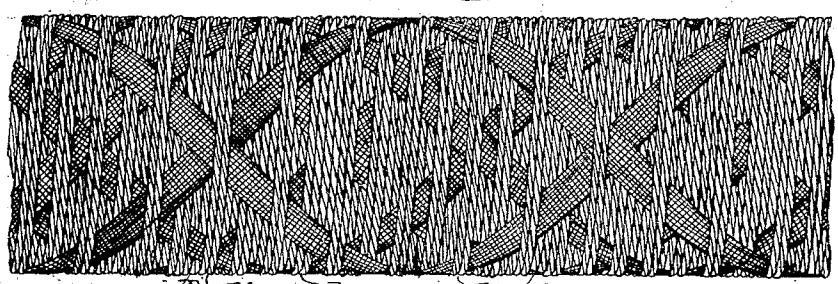


FIG. 8



Witnesses:
Ernest Mosman.
S. L. Gilmore

Inventor
Laurence A. Subers
by Wm M Morris
Attorney

L. A. SUBERS.

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7 SHEETS—SHEET 3.

FIG. 9

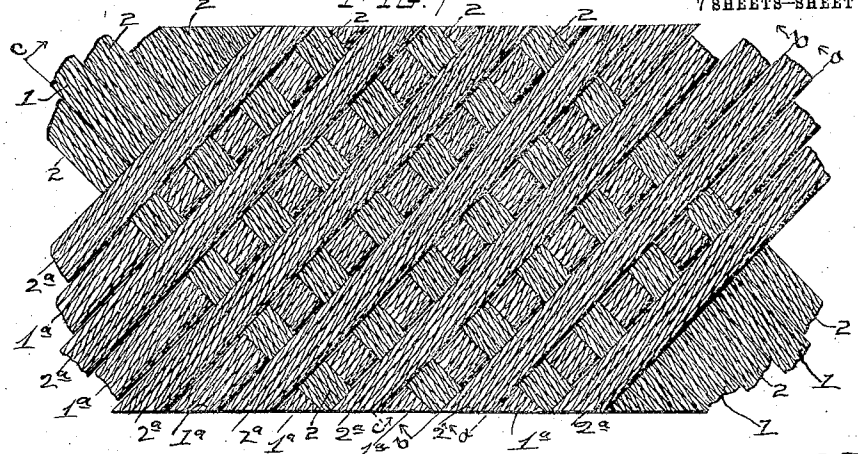


FIG. 10

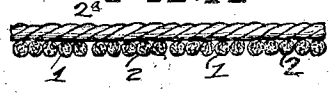


FIG. 11

FIG. 12

FIG. 13

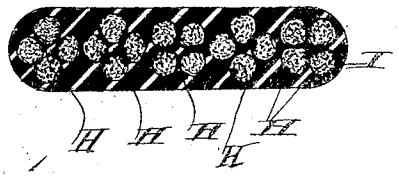
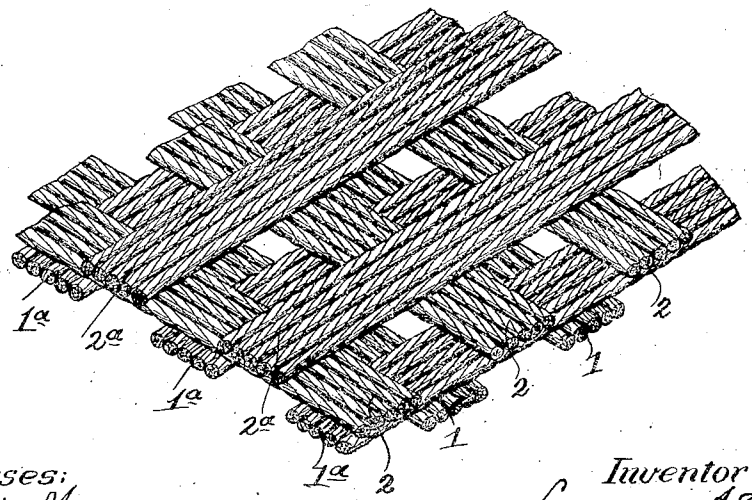


FIG. 14



Witnesses:
Ernest Mosman
S. L. Eskine

Inventor
Lawrence A. Subers
by Wm. M. Thomas
Attorney

L. A. SUBERS.

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7 SHEETS—SHEET 4.

FIG. 15.

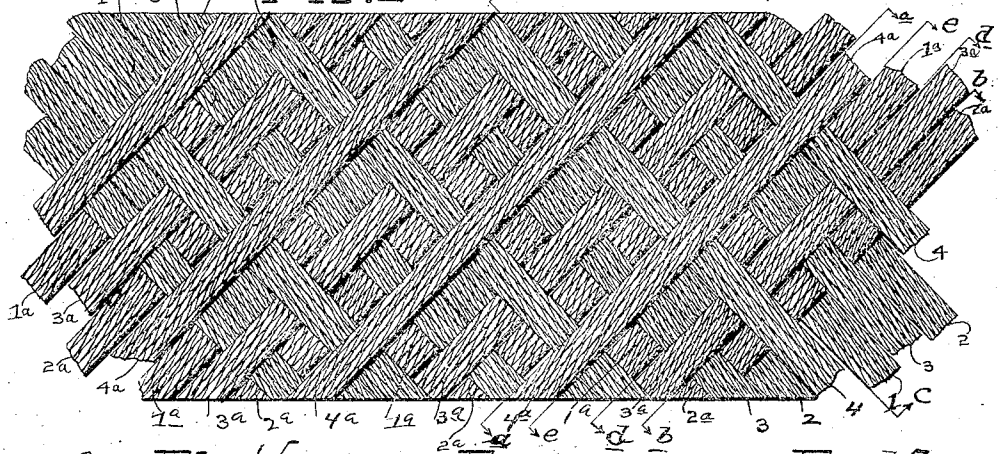


FIG. 16.

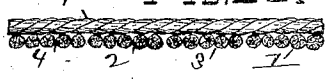


FIG. 17.

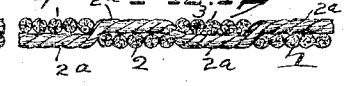


FIG. 18.

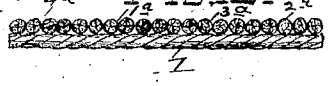


FIG. 19.

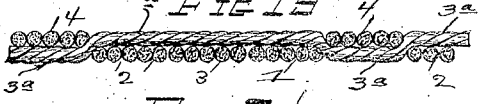
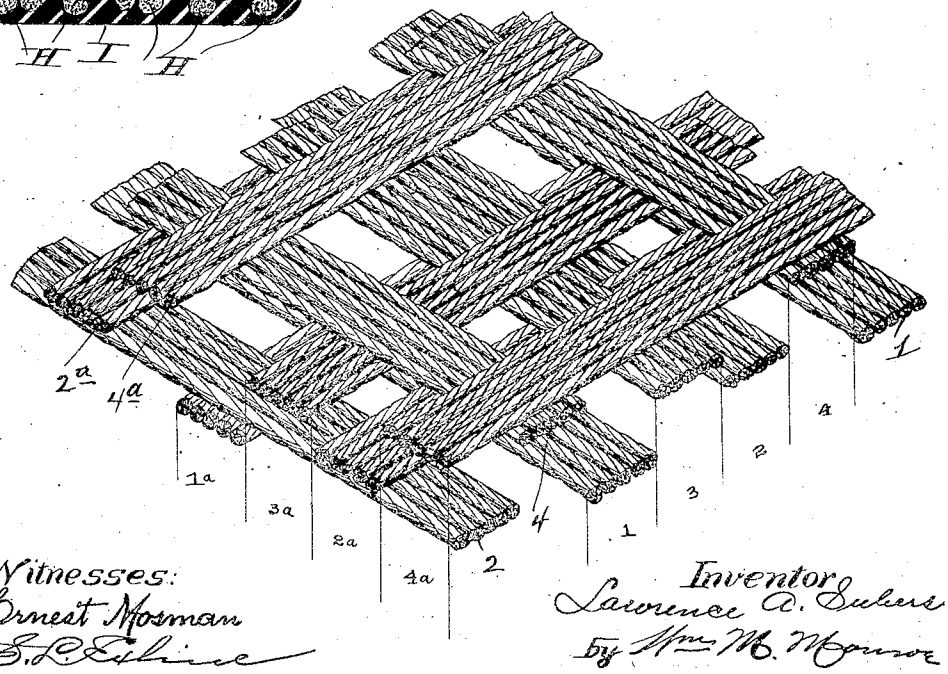


FIG. 20.

FIG. 21.

FIG. 22.



Witnesses:
Ernest Mosman
S. L. Eskine

Inventor
Lawrence A. Subers
By Wm. M. Monroe
Attorney

L. A. SUBERS.

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7 SHEETS—SHEET 5.

FIG. 23

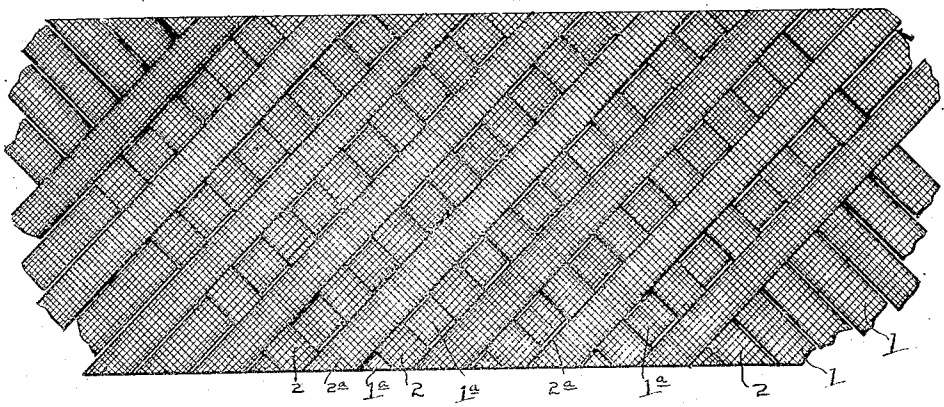


FIG. 24

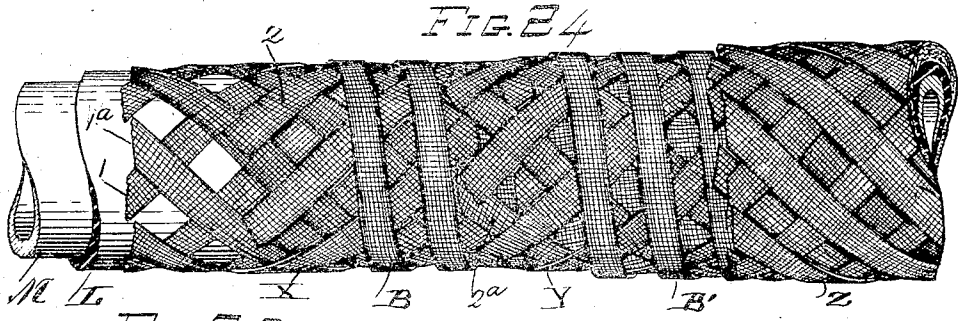
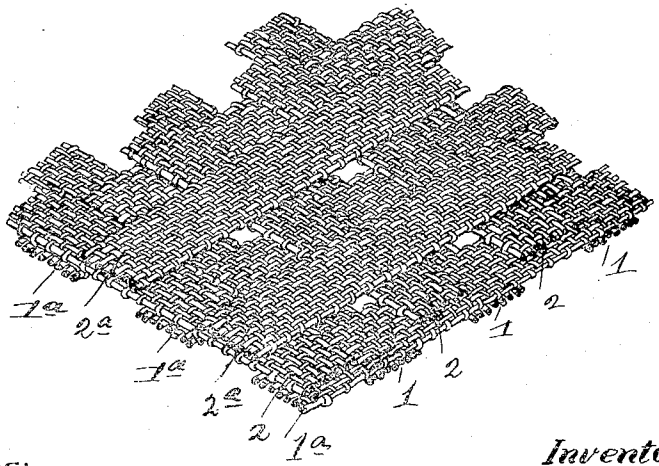


FIG. 25

FIG. 26



Witnesses:
Ernest Mosman
S. L. Gilmore

Inventor
Lawrence A. Subers
by Wm. McMorrow
Attorney

L. A. SUBERS.

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APPLICATION FILED OCT. 17, 1910.

1,011,090.

Patented Dec. 5, 1911.

7 SHEETS—SHEET 6.

FIG. 32

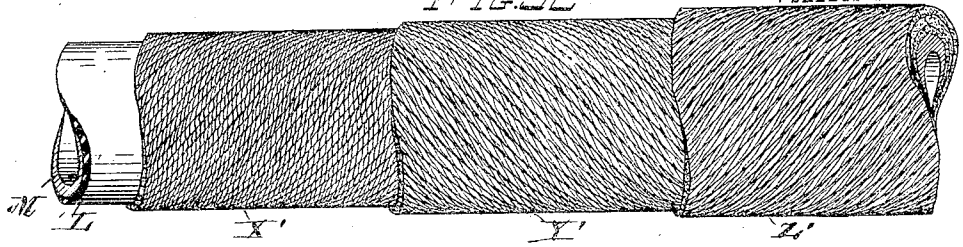


FIG. 28

FIG. 28a

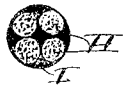


FIG. 29

FIG. 29a

FIG. 30

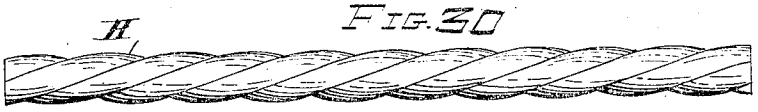
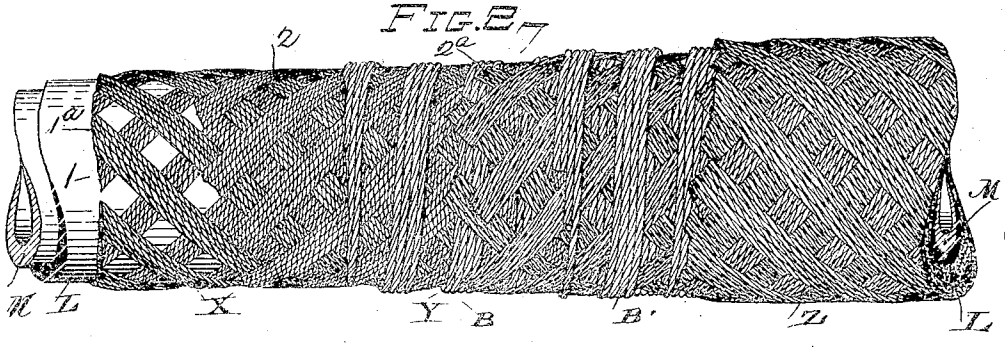


FIG. 30a

FIG. 31

FIG. 31a

FIG. 27



Witnesses:
Ernest Mosman
S. L. Eskine

Inventor
Lawrence A. Subers.
Wm. M. Mowry
Attorney

L. A. SUBERS.

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APPLICATION FILED OCT. 17, 1910.

1,011,090. Patented Dec. 5, 1911.

7 SHEETS—SHEET 7.

FIG. 33

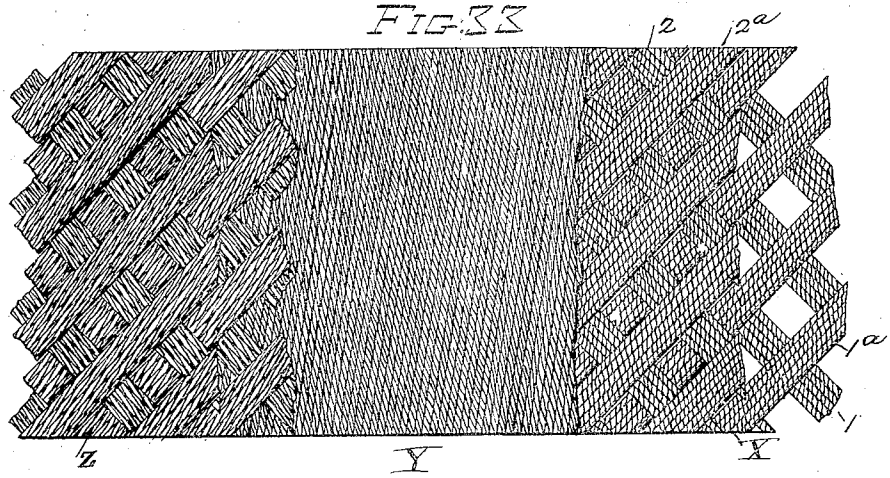
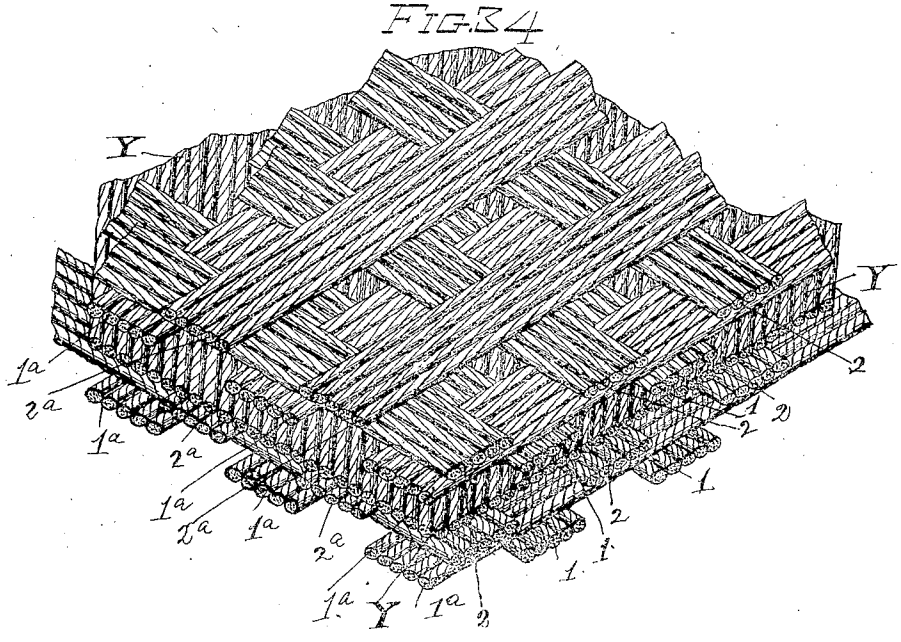


FIG. 34



Witnesses:
Ernest Mosman.
B. L. Eshine

Inventor
Lawrence A. Subers
by Wm. M. Johnson
Attorney

UNITED STATES PATENT OFFICE.

LAWRENCE A. SUBERS, OF CLEVELAND, OHIO.

FIRE-HOSE AND ANALOGOUS TUBING CONSTRUCTED OF LAMINATED COHESIVE INTERWOUND MEMBERS HAVING VARYING LIMITS OF ELASTICITY.

1,011,090. Specification of Letters Patent. Patented Dec. 5, 1911.

Original application filed January 31, 1910, Serial No. 540,982. Divided and this application filed October 17, 1910. Serial No. 587,632.

To all whom it may concern:

Be it known that I, LAWRENCE A. SUBERS, a citizen of the United States, and resident of Cleveland, in the county of Cuyahoga and State of Ohio, have invented certain new and useful improvements in fire-hose and analogous tubing constructed of laminated cohesive interwound members having varying limits of elasticity, of which I hereby declare the following to be a full, clear, and exact description, such as will enable others skilled in the art to which it appertains to make and use the same.

The objects of this invention are to provide a tubular fabric which will meet all of the various requirements of high pressure hose or tubing, as fire hose and hose adapted to analogous uses, wherein great resistance to internal pressure is demanded and in which tubular fabric when under pressure all torsional twist is practically eliminated while the diametral expansion and the longitudinal elongation or contraction can be controlled as desired and can be calculated, being made possible by the peculiar arrangement and construction of the component parts of the tubular fabric.

About the two most common forms of hose now manufactured have either a circular woven fabric, or have a fabric built up of strips of rubber frictioned textile material wound around a mandrel or form. The most obvious faults of the former are excessive elongation, and some torsional twist, with a corrugated interior, which increases the frictional resistance to the passage of fluid under high pressure. The second form of hose, shows excessive diametral expansion, with an excessive contraction or elongation in length, together with a large amount of torsional twist when put under high pressure. This excessive stretching of fabric is obviously detrimental in its effects weakening the hose so much that it is not reliable for any great length of time.

The present invention provides a tubular fabric wherein the diametral and longitudinal strains on the fabric from high internal pressures are so balanced by the peculiar construction of the fabric that neither produces any excessive stretching thereof.

The fabric of which the tubing is constructed may be described as a laminated-cohesive-interwound structure formed of cords or fibrous members cohering in adhesive material without braiding, weaving, interlacing or interlocking any one layer of the fabric.

It is understood that the prime necessity in the arrangement of the fibrous members in a fabric having great tensile strength in both lateral and longitudinal directions, that all fibrous members should have a controlled ratio of expansion and elongation and that the fibers or fibrous members forming the separate layers should have a predetermined ratio of expansibility relative to each other and be under a predetermined amount of tension, a condition impossible in woven fabrics where one set of fibrous members as the warp are relatively straight and the other set of fibrous members as the woof are extremely crooked and not under tension of any kind. In the herein described fabric the amount of diametrical expansion relative to the elongation can be approximately computed and controlled in each layer.

That portion of the tubular fabric designed to resist longitudinal stress may be formed of series of bands of twisted cords or threads, of bands of cabled yarns, of single cords or threads, of woven or other predetermined material, but whatever the material the first of a certain number of series is wound parallel to each other at a predetermined angle on a mandrel, so spaced that the remainder of these series would just fill the spaces between the members of the first series, and an equal number of series similarly spaced, wound parallel to each other at a reverse angle, the first of the latter series wound on top of the first of the former series, and the remainder of each series wound alternately in the same order, being compressed to fill the openings and cohering together in a coating of adhesive material, which may be vulcanizable. The resistance to lateral stress or expansion is obtained by means of close lying similar members wound in circumferential or spiral form in the fabric.

It may be stated that the fabric herein described is similar in character in all material respects to that described in some of the claims originally filed in my previous application Ser. No. 540,982, filed January 31, 1910, of which this is a divisional application, and is especially adapted for pressure tubing such as fire hose and analogous tubing. The fabric is constructed by means of

a fabric making device substantially like the machine invented by me and illustrated in my said application No. 540,982.

In the present application two systems of interwinding the cords or bands are described, which may be called the two group and four group systems respectively, but the system can be varied by increasing the number of groups occurring in each layer of the cords or bands without departing from the spirit of the invention or scope of the claims.

To control the relative expansion and contraction or elongation of the several layers under pressure so that a unitary effect will be produced a peculiar method or system is required. To have excessive expansion diametrically will cause the hose to shorten longitudinally and to have excessive strength circumferentially relative to its longitudinal strength will cause the hose to elongate under internal pressure. Therefore, if the strength of the fabric layers adapted to resist diametrical stress is equal to or balances the strength of the layers adapted to resist longitudinal stress, a balanced condition of strength in the hose is obtained in which there will be very little elongation or contraction or expansion. Hence both classes of layers of fabric are required to obtain the desired result, the parallel, equally spaced, interwound, and angularly laid layers previously described to resist the longitudinal pressure and a circumferentially laid or spiral layer or layers adapted to resist diametric pressure. By calculating the ultimate strength of the cords or bands laid at approximately 45° and 135° to any longitudinal surface line and then that of the circumferentially laid cords or threads, the stretch of the cords or threads may be so adjusted by variations in the numbers of twists per inch that all of these members when under maximum stress may be made to burst at the same moment, thus obtaining the joint maximum strength of all the members under stress. Again if the amount of stretch of which the inner layers are capable is less than the amount of stretch of which the outer layers are capable, the inner layers will rupture or break before the outside layers have a chance to receive their share of the internal pressure. Since the outer and inner layers are of different diameter the inner layers must expand more easily than the outer layers in order to stretch with the outer layers, therefore the stretching capacity of the inner layers must be accommodated to the stretching capacities of the outer layers which are of greater diameter, and the ratio of stretching capability must vary inversely to the respective diameters of the several layers. For this reason the fibrous members comprising the inner layers are caused to have a greater stretching capability than the outer layers by giving a greater number of twists per inch to the cords comprising them than to the cords comprising the outer layers. The ratio of stretching capability of any one layer can thereby be approximately controlled relatively to that of any one of the other layers. In the inner layers the number of twists per inch in each cord is greater than the number of twists in the outer layers and the component bands or members are also laid under less tension than in the outer layers. The effect is that the inside layers are first affected by internal pressure, and are free to expand and transmit the pressure to the outer layers before reaching the elastic or bursting limit. The ultimate bursting limit is affected by many things among which are the weight of the yarns employed in making the cords, the number of twists per inch in the cords in each layer the adhesions of the substance in which the cords or bands are embedded, the manner of interlaying the cords or bands to resist lateral and longitudinal separation thereof, and the amount of tension under which the bands comprising the fabric are laid.

The strength of this hose for resisting internal pressure is not materially lessened by kinking or bending upon itself under pressure, as in all fabrics now in general use.

The invention is hereinafter further described, illustrated in the accompanying drawings and specifically pointed out in the claims.

In the accompanying drawings Figure 1 is a side elevation of a section of a hose pipe showing parts broken away to reveal its construction, consisting of an inside lining of rubber upon a cylindrical mandrel, an inside fabric consisting of a two group system of parallel, equally spaced bands of twisted cords or threads wound part at an angle of preferably 45° and part at an angle of approximately 135° to any longitudinal surface line of that layer, enveloping this a circumferential or spiral layer composed of close wound cords, next a similar two group system of bands of cords to the first, and finally a rubber covering showing a five ply construction. Fig. 2 is a similar view showing a two group system of parallel, equally spaced bands of twisted cords or threads having the two halves of a circumferential layer of equally spaced parallel bands of cords or threads wound in two laminations in this two group system, the whole forming a three ply construction. Fig. 3 is a view of a five hose fabric, similar to that shown in Fig. 1 with the exception that the interwound bands are formed of parallel cabled threads cemented together by unvulcanized rubber. Fig. 4 is a similar view showing a three ply hose fabric, similar in construction to that shown in Fig. 2

but having the parallel, equally spaced bands of the two group system formed of cabled threads cemented together by unvulcanized rubber. Fig. 5 is a similar elevation of a hose in which the arrangement of bands in the several layers or plies is variously modified, the first layer showing an incomplete four group system of interwound parallel equally spaced twisted cords or threads combined with equally spaced, parallel bands of tape or other woven material, wound in the reverse direction, the second layer an incomplete four group system of circumferential spiral bands of twisted cords parallel and equally spaced, combined with two sets of tapes or bands of other woven material, the bands of each set equally spaced parallel and wound diagonally to the circumferential cords or threads, but reversely to each other. Fig. 6 shows a hose in layers of distinct character, the first a four group system of equally spaced, parallel interwound twisted cords or threads, the second and incomplete four group system of circumferentially wound, equally spaced, parallel bands of twisted cords or threads combined with two sets of bands of tape or other woven material the bands of each set parallel and equally spaced from each other, and wound diagonally to the circumferential cords or threads but reversely to each other while the third layer is a complete four group system of equally spaced, interwound bands of tape or other woven material. Fig. 7 is a similar elevation of a hose and of similar character to Fig. 6 except that the first layer consists of a complete four group system of equally spaced, parallel, interwound bands of tapes or other woven material while the remainder of the hose is identical in construction with Fig. 6. Fig. 8 shows a similar elevation of a single layer hose fabric identical in construction with the second layer shown in Fig. 5; Fig. 9 is a plan view of a portion of fabric formed on the two group system of parallel bands of equally spaced interwound bands of twisted cords; Fig. 10 is a transverse section thereof on line *a*—*a* Fig. 9; Fig. 11 is a similar section taken on line *b*—*b* Fig. 9; Fig. 12 is a similar section on line *c*—*c* Fig. 9; Fig. 13 is an enlarged transverse section of one band of twisted cords; Fig. 14 is an isometric view showing the relative positions of the several bands in the two group system before compressing or flattening into final shape, illustrating the order in which the bands are wound or laid, to form one layer of two plies; Fig 15 is a plan view of a fabric formed in a four group system; Fig. 16 is a transverse section thereof on line *a*—*a* Fig. 15; Fig. 17 is a transverse section on line *b*—*b*, Fig. 15; Fig. 18 is a transverse section on line *c*—*c* Fig. 15; Fig. 19 is a transverse section on line *d*—*d* Fig. 15; Fig. 20 is a transverse section on line *e*—*e* Fig. 15; Fig. 21 is an enlarged transverse section of one of the bands; Fig. 22 is an isometric view of a portion of the fabric shown in Fig. 15 before compressing or flattening the same, showing the relative position of the bands and the order in which they are wound; Fig. 23 is a plan view of a portion of fabric of which the tubing can be formed showing bands of woven material equally spaced apart and interwound in the two group system; Fig. 24 is a side elevation of a portion of a hose pipe showing a modified five ply construction, with a two group system of the first two plies, having bands of tape or other woven material interwound and equally spaced but having the two halves of a circumferential layer of equally spaced bands of tape or other woven material wound in two laminations one among the last laid members of the first two group system and one among the first laid members of the second two group system. Fig. 25 is an enlarged transverse section of one of the woven bands; Fig. 26 is a perspective view of a portion of the fabric showing the relative position of the bands when wound and the order of winding the same, so that one band will fill the space between two parallel bands when the fabric is compressed; Fig. 27 is a similar view, and is similar in construction to Fig. 24, being composed of bands of twisted cords or threads instead of bands of tape, and also having the threads composing the bands in the different layers of different number of twists per inch, the greatest number of twists per inch on the threads in the bands composing the inside plies and the least number of twists per inch on the threads in the bands composing the outside plies. Figs. 28, 29, 30 and 31 are elevations of portions of cord having different twists per inch: Figs. 28ª, 29ª, 30ª, 31ª are transverse sections thereof; in Fig. 32 the modified twist per inch in the several layers is illustrated in a simple construction of three layers of angularly wound twisted cords. Fig. 33 shows a plan view of a piece of fabric having the same construction as that used in the hose pipe shown in Fig. 1.

The various ways in which the fabric may be laid may be described as follows: In Figs. 1, 2, 3, 4, 9, 10, 11, 12, 14, 23, 24, 26 and 27, 33 and 34 are illustrated the two group system, and in Figs. 5, 6, 7, 8, 15, 16, 17, 18, 19, 20, and 22 is illustrated the four group system.

In the two group system 1, 1, represent a series of equally spaced, parallel bands of twisted cords wound or laid at an angle of approximately 45° or other predetermined angle to a horizontal surface line in that layer. These are wound as shown in the Figs. 1 to 7 and 24, 27 and 32 upon a lining

L of unvulcanized rubber, which is placed upon a mandrel M before forming the fabric and the bands may be either coated with liquid rubber as they pass to the mandrel or they may have been previously thoroughly coated and pass dry to the mandrel. Upon and crossing these bands are wound at a reverse angle the similar regularly spaced parallel series of bands 1^a, 1^a. A series of bands 2, 2, are then wound thereon parallel to the first series, in such a position as to overlay and cover the spaces left vacant between the first laid bands, and next a series of bands 2^a, 2^a, parallel to the second laid bands 1^a, 1^a, are wound or laid in such a position as to overlay the spaces intermediate between the second laid bands thus completing one layer of two thicknesses or plies of cord. This structure is more clearly shown in the enlarged Figs. 9, 10, 11, and 12. Here the positions of the different bands are clearly shown. When the fabric is pressed together the edges of the bands 2^a, 2^a, engage the edges of that portion of the bands 1^a, 1^a, which lie between the bands 2, 2, while the edges of the bands 2, 2, engage the edges of that portion of the bands 1, 1, that lie between the bands 1^a, 1^a. An enlarged transverse section of one band with its rubber coating is plainly shown in Fig. 13. Here H, H, are the cords which are embedded in the binding material I.

In Fig. 14 the relative positions of the bands are clearly shown before the members are pressed down upon each other into the positions shown in the sectional views Figs. 10, 11 and 12. In one and three-eighths inch internal diameter hose the fabric layer may comprise eight bands of cord wound in one direction, and eight bands wound at approximately right angles thereto, so as to entirely cover the mandrel at one application leaving no openings uncovered, forming one layer of fabric in the two group system consisting of two plies.

In Fig. 1 a second layer Y is formed of circumferentially or spirally laid twisted cord, and a third layer Z of interwound bands crossing each other, similar to the first named layer X. An outer layer L′ of rubber or of any desired material forms the outer coating.

In the hose shown in Fig. 2, first are wound the equally spaced, parallel bands 1, 1, second is wound the circumferential band whose convolutions B, B are equally spaced and overlay the bands 1, 1, third the equally spaced bands 2, 2, are wound, overlaying the circumferential band B, B and covering the space between the bands 1, 1: fourth are wound the equally spaced bands 1^a, 1^a, reversely to and over bands 2, 2; fifth is wound the circumferential band B′, B′ in equally spaced convolutions overlaying and covering the spaces between the convolutions of band B, B, while sixth are wound the equally spaced bands 2^a, 2^a, which overlay and cover the spaces between bands 1^a, 1^a. In all cases the last series of cords or bands is wound under considerable tension so as to compress the previously wound members into the position shown in Figs. 9, 10, 11 and 12, and previously described, the effect being to practically eliminate any lateral movement of any of the constituent bands.

In the four group system the order in which the several bands are wound is different from the two group system although the result in forming a two ply layer is somewhat similar.

In Fig. 22 the order of interwinding to fill the spaces between the equally spaced bands is clearly shown. First a series of bands 1, 1, are wound on the rubber covered mandrel, separated by a space wide enough to receive three similar, parallel wound bands. Next a similarly equally spaced series of bands 1^a is wound over series 1, 1, and at right angles thereto. Then a similar and equally spaced series of bands 2, 2, is wound parallel to 1, 1, and over 1^a, 1^a, but leaving an equal unfilled space on each side. A similar, equally spaced series of bands 2^a, 2^a, are then wound parallel to 1^a, over 2, 2, but leaving an equal unfilled space on each side. The next series of similar, equally spaced bands 3, 3, is wound in the spaces between bands 1, 1, and 2, 2, but over bands 2^a, 2^a. The similar, equally spaced series of bands 3^a, 3^a, is then wound in the spaces between bands 1^a, and 2^a, and over bands 3, 3. The similar, equally spaced series of bands 4, 4, is wound in the last unfilled spaces beside bands 2, 2, and over bands 3^a, 3^a. Finally the equally spaced series of bands 4^a, 4^a, are laid in the last unfilled spaces beside bands 2^a, 2^a, and over bands 4, 4, thus covering all spaces so that when the fabric is compressed it will assume in cross sections the appearance shown in Figs. 16, 17, 18, 19 and 20 of the thickness of two cords or plies.

The fabric is held together by means of adhesive rubber or other cementing material, without which it has no cohesion whatever but would immediately fall apart.

The hose shown in Figs. 3, 4, 5, 6, 7, 8 and 27 are obvious modifications in the order of winding the various members made possible by the principle of construction stated which permits of great variation to accommodate special requirements of use.

In Figs. 3 and 4 the bands running at approximately 45° and 135° are formed of cabled yarns incorporated in a binding of rubber in place of twisted cords, and the circumferential or spiral bands are formed of twisted cords. In this construction the durability of the fabric is great, since there

are fewer twisted cords employed in the construction and the friction of one member on another is much lessened. In Figs. 5, 6, 7, and 8 some of the bands and in some cases entire layers are formed on woven material, in place of cords, and in Fig. 32 all the layers of cords are spirally wound but not interwound at an angle of approximately 45° and 135°.

In Figs. 1, 2, 27 and 32, a modified ratio of twist per inch in the cords comprising the several layers is clearly shown.

In Fig. 1 the cords in layer X have a greater number of twists per inch than in layer Y and in layer Y than in layer Z, to obtain the desired relative ratio of expansion. The inner layer will expand more easily than either of the others, and the outer layer the least of all. The effect being that internal pressure will be evenly distributed throughout the layers. The same condition of modified twist in the cords is seen also in the other figures last mentioned. Various amounts of twist per inch are shown in the cords illustrated in Figs. 28, 29, 30 and 31 largely magnified.

In Fig. 32 the modified twist per inch is illustrated in the simplest possible arrangement layers x', $4'$ and $7'$ of cords.

After the hose has been constructed with a binding of adhesive vulcanizable material throughout, the outer coating is attached, and all parts are vulcanized together.

It is obvious that if metallic members were interlaid with the fibrous members or in place of some of them, that the hose can be made strong enough to resist external pressure so as to be used for suction hose.

It is obvious that for the purpose of constructing suction hose that the same system may be employed wherein metallic members may be combined with fibrous material or members without departing from the scope of the invention.

Having described the invention, what I claim as new and desire to secure by Letters Patent is:

1. In a hose, in combination, a rubber lining, a series of fibrous members coated in rubber and spaced apart and running in a parallel direction to each other at an angle to the axis of the hose upon said lining, a second series of members of fibrous material coated in rubber and spaced apart and running parallel to each other and crossing the first series at an angle, a third series of rubber coated fibrous members laid thereon intermediate of the first named series of bands and parallel thereto to cover the spaces between the bands in the first named series, and a fourth series of rubber coated fibrous members parallel to said second series and positioned to cover the spaces between the members of the second series, a layer of parallel spirally laid members coated with rubber, wound upon said interlaid members, and an outer inclosing layer, all layers compressed and cohering together to form a unitary structure.

2. In a hose, in combination, a rubber lining, a series of parallel spaced fibrous members coated in rubber and laid upon said lining at an angle of substantially 45°, a series of similar subsequently laid spaced members crossing the same at the same angle, similar spaced members interlaid and arranged to cover the intervening spaces between the spaced members of the said first and second series, a transversely and spirally laid layer of twisted cords, and an exterior coating for the hose, said members and outer layer being inclosed in rubber, and said subsequently laid series of members compressed to lie in and fill the spaces between said spaced parallel members of the first laid series and of the spaced members of following series.

3. In a hose, a vulcanizable lining, a first series of parallel fibrous members laid thereon at an angle of substantially 45° and spaced apart, a second series of similarly spaced fibrous members crossing the said first series at substantially right angles, and subsequently laid series of similarly spaced fibrous members, said subsequently laid series being first laid to interlay with the spaced members of the first series and then with the spaced members of the crossing series until all spaces are covered said spaced members compressed together to fill all said spaces, an exterior layer of spirally wound fibrous members, an exterior coating of vulcanizable material and a coating for each fibrous member of vulcanizable material, said complete hose finally vulcanized substantially as described.

4. In a hose, a rubber lining, a series of fibrous members coated with elastic vulcanizable material wound thereon at substantially 45°, and evenly spaced apart, a second series of similar and similarly wound and coated spaced fibrous members wound thereon at a reverse angle, subsequent series of fibrous coated members interwound thereon at similar angles to cover the openings left between the previously wound series, spirally wound coated fibrous members, the tension upon one of the outer plies of members serving to compress the interwound members to fill the spaces between them.

5. In a hose, a rubber lining, a series of fibrous members wound thereon and regularly spaced apart, a second series of similarly spaced fibrous members wound thereon at right angles thereto, subsequently spaced series of fibrous members wound thereon in succeeding plies parallel to said first wound spaced members and interwound between them to cover the said spaces between them

until all spaces are covered, the outermost series being laid under greater tension than the inner series whereby the several series are compressed together and into the spaces to close the same, to form one ply of members running in each direction, and to jointly form one layer the members of which cohere together.

6. In a hose, a rubber lining, a series of spaced fibrous members wound thereon, a second series of similar members wound at an angle thereto, a third series wound parallel to the first series and intermediate of said spaced members, a fourth series wound parallel to said second series and intermediate of the spaced members, the outer series being wound under tension, whereby the members are compressed together to fill all spaces between them whereby a two ply fabric is produced, a series of circumferentially wound members and a vulcanizable binding material for said members.

7. In a hose, a rubber lining, a series of spaced fibrous members wound thereon, at an angle, a second series of spaced fibrous members wound thereon at an angle to said first series, and subsequently wound series of spaced fibrous members alternately parallel to said first and second wound series, and subsequently laid series of spaced fibrous strands positioned to cover the spaces of previously wound members, the outer of said series being placed under tension whereby said members are compressed together and the subsequently wound spaced members are forced into the spaces between the first wound spaced members thus forming a two ply fabric, the edges of the members of one ply engaging the edges of the other ply, and circumferentially wound fibrous members substantially as described.

8. In a hose, an inner lining of vulcanizable material, a series of spaced members of fibrous material wound thereon at an angle of substantially 45°, a second series of similar spaced members crossing the first named series at a reverse angle, subsequently laid series of spaced fibrous members wound parallel with the first and second series, alternately, and positioned to cover the spaces therein to form a two ply layer and circumferentially wound spaced fibrous members laid alternately over one series of said first layer and alternately over another series, so as to fill all spaces between said circumferential spaced members, one of said series of members being wound under tension, whereby the other series of members are compressed together.

9. In a hose, a lining of rubber, spaced interwound crossed members of twisted cord crushed together to form an unwoven two ply layer, and a spirally wound layer of twisted cord, the ratio of twists per inch in the cords comprising the different layers varying inversely as their diameters.

10. In a hose, a spaced series of laminated interwoven members of twisted cord crossing each other, and crushed together to form two plies, with the edges of the members of one ply engaging the edges of the members of the other ply, and a layer of spirally wound twisted cord, the ratio of twists per inch in the layers varying inversely as their diameters and a cohesive means for cementing the fabric together.

11. A hose composed of a series of superimposed layers of parallel cords, laid at predetermined angles, the number of twists per inch in the cords comprising the inner layer being greater than the number of twists per inch in the cords in the next succeeding layer, and the number of twists per inch gradually decreasing in the subsequently applied layers and a cohesive means for cementing the fabric together.

12. A hose composed of a series of superimposed layers of parallel cords laid at predetermined angles to the axis of said tube, and the cords in the several layers being provided with varying selected numbers of twists per inch according to the relative circumferential areas of the several layers, the cords in the inner layer having the greatest amount of twist and a cohesive means for cementing the fabric together.

13. A hose, composed of a series of superimposed layers of parallel cords, said cords or threads running at a predetermined angle in each layer and running at an angle to each other in adjoining layers, the number of twists in the cords per inch in said layers becoming relatively less as the circumferential areas of the layers increase, whereby the stretching capabilities of the several layers will vary inversely as the respective diameters of the several layers and a cohesive means for cementing the fabric together.

14. In a hose, separate layers superimposed upon each other, each layer composed of twisted cords laid at a predetermined angle, the number of twists per inch in the cords in the inner layer being the greatest, and the number of twists per inch in the cords in each succeeding layer being relatively less and proportioned to the limit of elasticity desired, and difference in the diameter of said layers and a cohesive means for cementing the fabric together.

In testimony whereof, I hereunto set my hand this 14th day of October 1910.

LAWRENCE A. SUBERS.

In presence of—
ERNEST MOSMAN,
S. L. EXLINE.