July 18, 1961 H. F. FRITH, JR 2,992,550

KNITTED MESH

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Fig. 2.

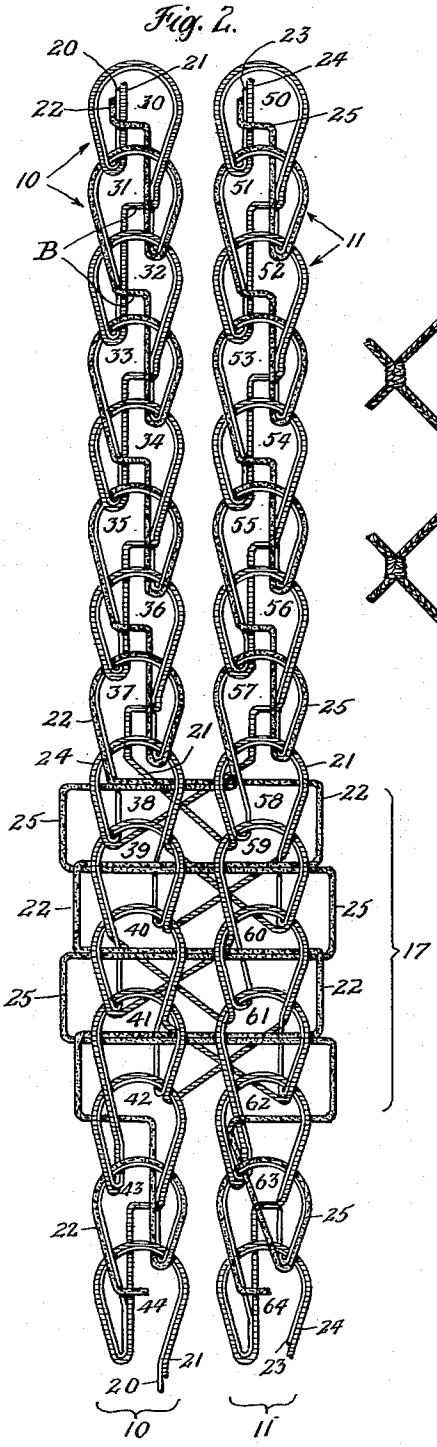

Fig. 1.

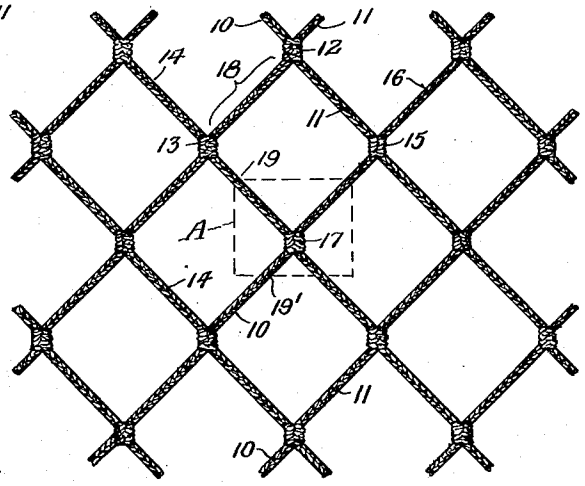

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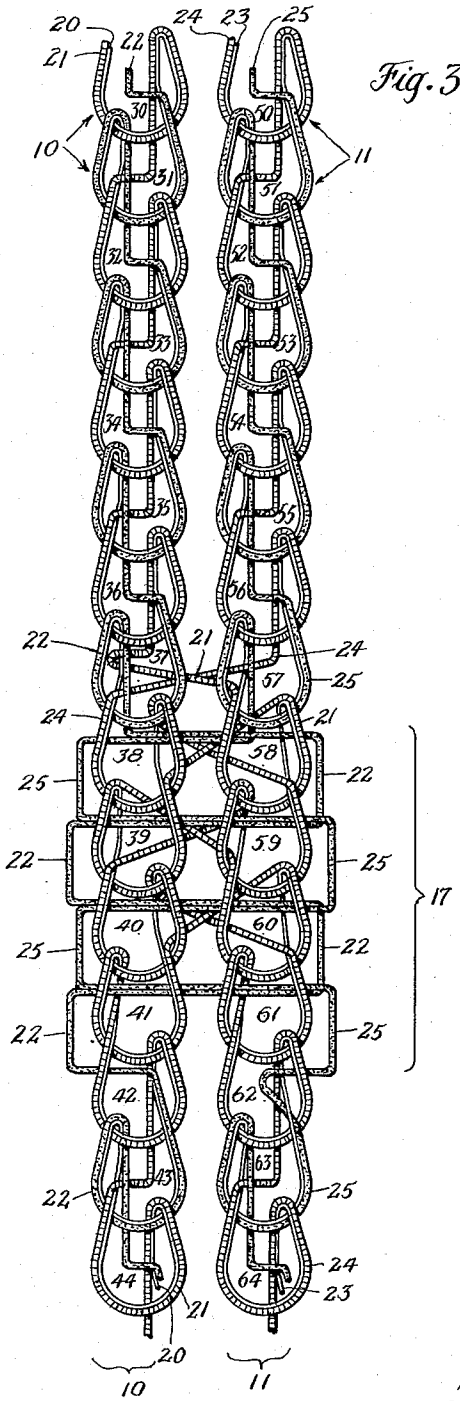
Fig. 3.



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2,992,550

KNITTED MESH

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20 Claims. (Cl. 66—195)

The present invention relates to netted materials produced entirely by knitting, and to the manner in which the warp chains are formed and secured together at spaced junction points or "knots" to form meshes.

It has long been known that netted articles can be produced by knitting, and it is customary to use a Raschel knitter for this purpose. The operation has been performed, sometimes by employing two yarns for each warp chain, but most commonly by knitting a plurality of single yarns simultaneously to form the several warp chains, and then interknitting the warp chains at the junction points or "knots."

Nets of this general type are subject to a very serious difficulty, in that the breaking of one of the yarns will cause the warp chain to ravel or "run," progressively, throughout its length, so that the net literally falls apart when a warp chain snags or breaks. Efforts to alleviate this problem have been made by using lay-in yarns to form the knots, instead of interknitting warp yarns. This expedient has resulted in some improvement, but has by no means solved the problem. It may nonetheless be used to advantage where the netted material is not required to undergo severe stress in use, and where the construction is inherently of very light weight. But it has proved impossible heretofore to produce nets having high tensile strength, and which are substantially immune to ravelling in the event of yarn breakage.

It is an object of this invention to provide a netted mesh of extremely high tensile strength, produced entirely on a knitting machine, and so constructed that the knots will neither creep, break, or ravel, and that runs will not progress, if a warp yarn breaks, beyond the point at which that warp chain first knots with an adjacent chain.

Since the net of this invention is outstandingly useful in deep sea fishing operations, it will be described with reference to that field of use, although it will at once become apparent that the same characteristics which are of such value in a fish net will also have importance in many other fields, particularly in the formation of netted laundry bags, and in the production of nets for athletic use, such as tennis nets, badminton nets, handball nets, and the like.

A net composed of the knitted mesh of this invention is relatively inexpensive to manufacture, and has a long life expectancy. When made of high tensile synthetic yarns, such as nylon, it is notably light in weight in proportion to its strength, and even when composed of low strength yarns, is not excessively bulky.

The structure which affords the advantages mentioned is described in greater detail in the comments which follow, and is illustrated, in its preferred form, in the accompanying drawings, in which:

FIGURE 1 is a plan view of a section of mesh embodying this invention, in the extended position ordinarily assumed in use.

FIGURE 2 is a plan view, on a highly-enlarged scale, of a portion of FIGURE 1, such as that indicated by the letter A, showing two warp chains in the collapsed condition of the net, with the knot which joins them.

FIGURE 3 is a plan view of the identical pattern shown in FIGURE 2, but shows it as actually knitted, i.e., from top to bottom of the figure.

Referring now to FIGURE 1 of the drawings, it will

be seen that the net, generally considered, is made up of a plurality of connected warp chains. When the net is relaxed, these chains are generally in susbtantially parallel relationship, as they are shown in FIGURE 2. But when the net is in use, the warp chains are separated so as to expand and open the mesh.

Considering now the pair of warp chains designated by the reference numerals **10** and **11**, shown in the center of FIGURE 1, it will be seen that the members of this pair are united by a knot **12**, and then separate once more to form the legs of a mesh, the warp chain **10** being united by the knot **13** to an adjacent warp chain **14**, and the warp chain **11** being united by a knot **15** to an adjacent warp chain **16**. The warp chain **10**, after passing through the intersection point **13**, and the warp chain **11**, after passing through the knot **15**, return to the knot **17**, which is directly in line with the knot **12**, and this type of construction is characteristic of the mesh portion of the net. The portion **18** of a warp chain which lies between two adjacent knots may be referred to as a "leg" of the mesh.

FIGURES 2 and 3 of the drawing show, in greatly enlarged form, a portion of the mesh such as that outlined by dotted lines in FIGURE 1, and marked with the reference character A. That portion of the warp chain **10** which lies between the points **19** and **19'** is shown on the left in this figure, and a corresponding portion of the warp chain **11** is shown on the right. The knot **17** is illustrated in detail, being opened out in FIGURE 2 to show to best advantage the laid-in yarns interconnecting adjacent chains, and in FIGURE 3, to show more clearly the disposition of the cross-over yarns. Likewise, for better illustration of the interengagement of the yarns, FIGURE 2 illustrates the completed mesh as though knitted from bottom to top of the figure, whereas FIGURE 3 shows the identical pattern, but as actually knitted, i.e., from top to bottom of the figure.

Considering now the basic construction of the warp chains, it will be seen that each chain, insofar as the legs of the meshes are concerned, is formed of three yarn components, these three components being simultaneously interknitted as the net is formed. The basic pattern of the warp chain is provided by the warp yarn **20**, which is chain-knit from end to end of the warp chain **10**, forming a plurality of interknitted loops, numbered from **30** to **44**, inclusive. This yarn is shown without shading in the drawing.

The second component of the warp chain **10** is a cross-knit yarn **21**, which is indicated by horizontal sectioning. This cross-knit yarn interknits with the warp yarn for one stitch **30**, is laid-in for the next stitch **31**, interknits the following stitch **32**, and so on, until it reaches the area in which the warp chain **10** is to be knotted to the warp chain **11**.

The third yarn component of the warp chain **10** is the lay-in yarn **22**. This is shown stippled. It is merely laid-in on the stitch **30** of the warp chain **10**, but is interknitted with the following stitch **31**, being then laid-in for one stitch and once again knitted in. It will thus be seen that the warp yarn **20** which knits with itself at every loop, also interknits alternately with the cross-stitch yarn, and with the lay-in yarn, until the junction point is reached.

The right-hand warp chain **11** is formed in precisely the same way as the warp chain **10**. The warp yarn **23** knits a stitch with the cross-stitch yarn **24**, and at the next loop with the lay-in yarn **25**. The loops of the resultant chain, numbered from 50 to 64, correspond with the numbers applied to the loops of the chain **10**. When the chains **10** and **11** have reached the point at which a knot is to be formed, the following operations occur.

The cross-stitch yarn **21** crosses from the warp stitch

37 to the warp chain 10, forwardly to warp stitch 58 of the warp chain 11, which stitch, as is clearly seen in the drawings, interknits with stitch 57 of warp chain 11. At the following stitch 38, the lay-in yarn 22 passes transversely from warp stitch 38 to the chain 10 to and through warp stitch 58 of the warp chain 11. It is then advanced one step and again traversed, this time from warp stitch 59 of the chain 11 to and through warp stitch 39 of the chain 10. Meanwhile, the cross-stitch yarn crosses back from warp stitch 58 of chain 11 to form warp stitch 39 of chain 10, which interknits with the preceding warp stitch 38.

While the cross-stitch and lay-in yarns of warp chain 10 are performing these operations, precisely opposite operations are being followed by the cross-stitch yarn 24 of warp chain 11, and by the lay-in yarn 25 of the same chain. That is to say, at stitch 57 of chain 11, the cross-stitch yarn crosses to form stitch 38 of warp chain 10, which interknits with stitch 37 of the same chain, and then passes from stitch 38 to stitch 59 of chain 11. Similarly, lay-in yarn 25, after forming stitch 57 of warp chain 11, is traversed to and through loop 38 of warp chain 10, advanced one stitch, and passed transversely back through loop 39 of chain 10 and loop 59 of chain 11, all as clearly seen upon inspection of the drawing. These double traverses (as from chain 10 to chain 11 and back to chain 10) may be repeated several times, if desired. For practical purposes, I find that two double traverses afford ample strength and security, and have therefore, illustrated that type of knot. Where high strength is not of prime importance, one double traverse will be sufficient.

It is, of course, possible to secure wide variations in strength and weight by making appropriate changes in the nature of the yarn components of which the mesh is made. In the preferred embodiment illustrated, I have shown a deep sea fishing net which has a tensile strength in excess of 40 pounds. This is strong enough to handle fish of rather substantial size. The yarn components of this net are all of nylon. The warp chain is a single end of 210 denier; the cross-knit chain is composed of three ends of 210 denier nylon handled as one end; and the lay-in yarn also comprises three ends of 210 denier yarn handled as one end.

Each traverse of one of these yarn components, therefore, represents three ends moving from one chain to the other, and a double traverse (i.e., when the same component moves back to its original chain), represents six strands of 210 denier yarn. When the knot is formed as here shown, with a lay-in yarn from chain 10 and a lay-in yarn from chain 11 each making a double traverse, and with a cross-knit yarn of each chain doing likewise, there will be sixteen runs of yarn from chain to chain in each knot—that is, a total of forty-eight ends.

In producing a deep sea fishing net, it is preferable to use yarns composed entirely or chiefly of synthetic hydrophobic fiber, such as nylon. Such yarns have many advantages for this use, including high tensile strength, immunity to swelling and water damage, and resistance to rotting. Natural fibers can also be used for this work, but with slightly less desirable effect.

When natural fibers are used for producing a fish net, it is essential to impregnate the finished article with a water resistant material, such as tar or other resinous composition. Indeed, it is preferable in any case to impregnate a fish net with such material, even one composed entirely of hydrophobic fiber. This is because, in the knitting process, innumerable voids are formed between strands of yarn, and these will prevent the net from sinking, unless they are filled with some impregnant. Furthermore, the binding action of the impregnant materially increases the strength of the net as a whole, even when woven entirely of synthetic yarns. Still further, if there is no impregnant, the mesh is extremely limp and difficult to handle. The impregnant stiffens the product just enough to overcome this difficulty.

It is, of course, apparent that where the net is to be used in situations where immunity to water damage is not of primary importance, yarn composed of almost any fiber may be successfully employed.

One of the outstanding characteristics of the mesh of the present invention is its resistance to ravelling. When a knitted net of prior types runs of ravels, there is not only a break in the continuity of the net itself, but also a pronounced tendency for the meshes both to the right and to the left of the break to close up, or gather, thereby widening the opening still further. Since any break which occurs in the net of the present invention will, at the most, progress no farther than the nearest knot, there is no opportunity for meshes near the break to gather in this way.

The high resistance to ravelling or running which is manifested by the net of this invention is attributed, not only to the number of runs of interconnected yarns forming each knot, but also to the fact that the yarns employed are used in different ratios. It takes about 4 feet of warp yarn to produce 1 foot of knitted warp chain; it takes about 3.15 feet of cross-knit yarn to produce 1 foot of warp chain; and it takes about 2.80 feet of lay-in yarn per foot of final product. It is believed that the very fact that the yarns used are used in different ratios, has an important bearing on the ability to withstand ravelling, for if one of these yarns breaks, it will not take the other two yarns with it, but will shortly snarl with these yarns, because of the different ratio of use. If the lay-in yarn and the cross-stitch yarn are multiple-end yarns, this fact alone will increase the tendency of broken ends to snarl. The locking bight B formed in the chain leg by the yarn laid-in at each loop also aids in preventing ravelling. Whatever the cause, it has been observed that if one of the yarns breaks in the leg of the mesh, there will not infrequently be no substantial ravelling at all, even in that leg. If two yarns of one leg break, the third yarn is likely to break also. But even under these conditions, the three interknitted yarns will tangle and the run will not progress beyond the knot.

The importance of this feature will be readily appreciated when one pauses to consider the amount of time and effort necessary to stretch a deep sea net, and the economic disaster which follows if the net tears apart when loaded, and the fish escape. It is not unusual for deep sea nets to extend for hundreds of yards, and a complete break in the mesh at any point will represent the loss of tremendous quantities of fish.

Insofar as actual operation of the machine is concerned, very little need be said. The Raschel knitter is entirely familiar to the trade, and the adjustments needed to produce the mesh disclosed will be obvious to any experienced operator who has read this disclosure.

Briefly, the warp yarn is carried throughout the operation on the same needle, producing a series of chain stitches, each interknitted with the preceding stitch. The cross-knit yarn is set to knit one stitch and skip one stitch alternately on the same needle throughout the operation of the knitting of each leg 18. When it reaches the point at which an intersection or knot is to be formed, it is shifted to a corresponding knitting needle of the adjacent chain, knits one stitch on that needle, and is then shifted back to its original needle. Meanwhile, the cross-knit yarn of the second chain has transferred to the needle vacated by the cross-knit yarn first mentioned, and is knitted one stitch by that needle and returned to its original needle in the second warp chain.

The case is similar with the lay-in yarn, which is carried on the same needle while it is forming the leg 18, and that needle is set to knit one stitch and skip one stitch and knit one stitch again, noting only that the stitches which the lay-in yarn knits alternate with those knitted by the cross-stitch yarn. When the knot 17 is reached, the lay-in yarn is traversed across two needles, back and forth, for a series of four stitches, returning finally to its original warp chain and to its original needle.

Since each of these operations is fully understood, per se, it has been regarded as unnecessary to illustrate the mechanism used, or the manner in which it is set up to perform them simultaneously.

The technique of binding the edges of a net is also very well known, and for that reason is not illustrated here. It may be accomplished by securing the warp ends to a binding rope in the usual manner, or by stitching these ends in a binding tape, which may or may not enclose a supporting rope, as desired.

I claim:

1. A knitted mesh comprising a plurality of warp chains each of which consists of three component yarns, the first of which component yarns is chain knitted throughout the length of the chain, the second of which is knitted with the first into certain stitches of said chain and laid in through other stitches intermediate said certain stitches, and the third of which is laid in through stitches in which the second yarn is knitted and is knitted with the first yarn in intermediate stitches through which the second yarn is laid; each of said warp chains being interconnected at spaced points therealong to an adjacent warp chain on one side, and at spaced points between the points first named to an adjacent warp chain on the opposite side, each such interconnection comprising at least one of said second and third yarn components of one chain.

2. The mesh of claim 1, wherein each inter-connection between warp chains comprises both the second and the third yarn components.

3. The mesh of claim 2, wherein each interconnection is formed by one of said yarn components being interknitted with the adjacent chain and the other interengaging yarn component being inlaid through stitches of the adjacent chain.

4. The mesh of claim 1, wherein each interconnection is formed by a yarn component of one chain being interknitted with the adjacent chain.

5. The mesh of claim 1, wherein each interconnection between warp chains is characterized, in that any yarn component of one chain which extends into interengagement with an adjacent chain extends back to its original chain and continues therein to a subsequent point of interconnection.

6. The mesh of claim 1, characterized in that each of the warp chains consists, throughout its length, of the same yarn components, save only at the interconnection points.

7. A knitted mesh comprising a plurality of primary warp chains one of which is interconnected at spaced points there along to an adjacent warp chain on one side and at spaced points between the points just named to an adjacent warp chain on its other side, each of said chains comprising a first yarn which is chain-knitted and lies entirely in the same chain throughout the length thereof, plus a second yarn, which is knitted with spaced apart stitches of said first chain-knitted yarn, plus a third yarn which is knitted with stitches of the first yarn other than those last mentioned, said second and third yarns likewise lying within the same chain throughout the length thereof, save only at points of interconnection with an adjacent chain, at each of which points they and two corresponding yarns of said one adjacent chain extend back and forth between the respective two chains, each being engaged with stitches of the adjacent chain and extending back to its primary chain.

8. The mesh of claim 7 in which the second yarn of each chain is inlaid through any stitch of the first chain-knitted yarn with which the third yarn is knitted, and vice versa.

9. The mesh of claim 7 in which at least one of said second and third yarns is knitted with a small number of stitches of an adjacent chain at each point of interconnection.

10. The mesh of claim 7 in which at least one of said second and third yarns is inlaid through a small number of stitches of an adjacent chain at the point of interconnection.

11. The mesh defined in claim 7, the yarns of which are composed of synthetic fiber.

12. The mesh of claim 11, in which the synthetic fiber is nylon.

13. The mesh of claim 7 in which the chain-knitted yarn consists of a single end, and in which each of the remaining yarn components consists of three ends, the three ends in each case being disposed as one.

14. The mesh of claim 7 in which the three yarns named are present each in a ratio differing from either of the other two.

15. The mesh of claim 14 in which, of the total amount of yarn present in the mesh, the first yarn constitutes the greater proportion, the second yarn an intermediate proportion, and the third yarn the smallest proportion.

16. The mesh of claim 14 in which, of the total amount of yarn in the mesh, the first yarn is present in the ratio of four parts, to 3.15 parts of the second yarn and the third yarn is present in the proportion of 2.80 parts.

17. In a high-strength purse seine for fishing, a net structure consisting of side-by-side warp knit chains each interconnected at points along its length with the adjacent chain on its one side and at intervening points with the adjacent chain on its other side, the runs of the chains between the said interconnection points bounding the meshes of the net, each chain comprising three yarn components, the first being knitted upon itself throughout to form a primary continuous chain, the second being knitted along with the first in alternate stitches in the mesh-bounding runs of said primary chain and laid through the intervening stitches thereof, the third being knitted along with the first in the said intervening stitches and laid through the said alternate stitches, the second component at each interconnection point extending back and forth between its primary chain and the adjacent chain and being knitted in a small number of stitches in the latter, the third component at each interconnection point extending back and forth between its primary chain and the adjacent chain and being inlaid through a small number of stitches in each.

18. A mesh net of knitted yarns comprising a plurality of continuous chain-knit warp chains each of which is interconnected alternately at spaced intervals with the chain on its right and with the chain on its left, by yarns inlaid through certain stitches of said continuous chains and also by yarns knitted in doubled relationship with certain stitches of said continuous chains, each such interconnection point comprising (1) a yarn knitted with a stitch of the left chain and extending in an adjacent course to the right chain, being there inlaid through two stitches of said right chain and thence extending back in the same course as the second of said two stitches of the right chain to the left chain, and being inlaid with a stitch of said left chain; and (2) a corresponding yarn of the right chain, extending in the opposite direction in the same respective courses and engaging the stitches of the respective chains in the same manner.

19. A mesh net of knitted yarns comprising a plurality of continuous chain-knit warp chains each of which is interconnected alternately at spaced intervals with the chain on its right and with the chain on its left by yarns inlaid through certain stitches of said continuous chains and also by yarns knitted in doubled relationship with certain stitches of said continuous chains, the interconnection between any two chains at any interconnection point comprising (1) a yarn knitted in the left chain, and extending back and forth between the chains in adjacent

courses thereof, further being knitted with stitches of the right chain and with a stitch of the left chain; and (2) a corresponding yarn of the right chain extending in the opposite direction in the same respective courses and engaging the stitches of the respective chains in the same manner.

20. A mesh according to claim 18 wherein the interconnection between any two chains at any intersection point also comprises a yarn knitted in the left chain, and extending back and forth between the chains in adjacent courses thereof, further being knitted with stitches of the right chain and with a stitch of the left chain, together with a corresponding yarn of the right chain extending in the opposite direction in the same respective courses and engaging the stitches of the respective chains in the same manner.

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UNITED STATES PATENT OFFICE

CERTIFICATE OF CORRECTION

Patent No. 2,992,550 July 18, 1961

Hagin Franklin Frith, Jr.

It is hereby certified that error appears in the above numbered patent requiring correction and that the said Letters Patent should read as corrected below.

Column 3, lines 1 and 5, for "to", first occurrence, each occurrence, read -- of --; column 4, line 7, for "of", second occurrence, read -- or --.

Signed and sealed this 12th day of December 1961.

(SEAL)
Attest:

ERNEST W. SWIDER
Attesting Officer

DAVID L. LADD
Commissioner of Patents

USCOMM-DC