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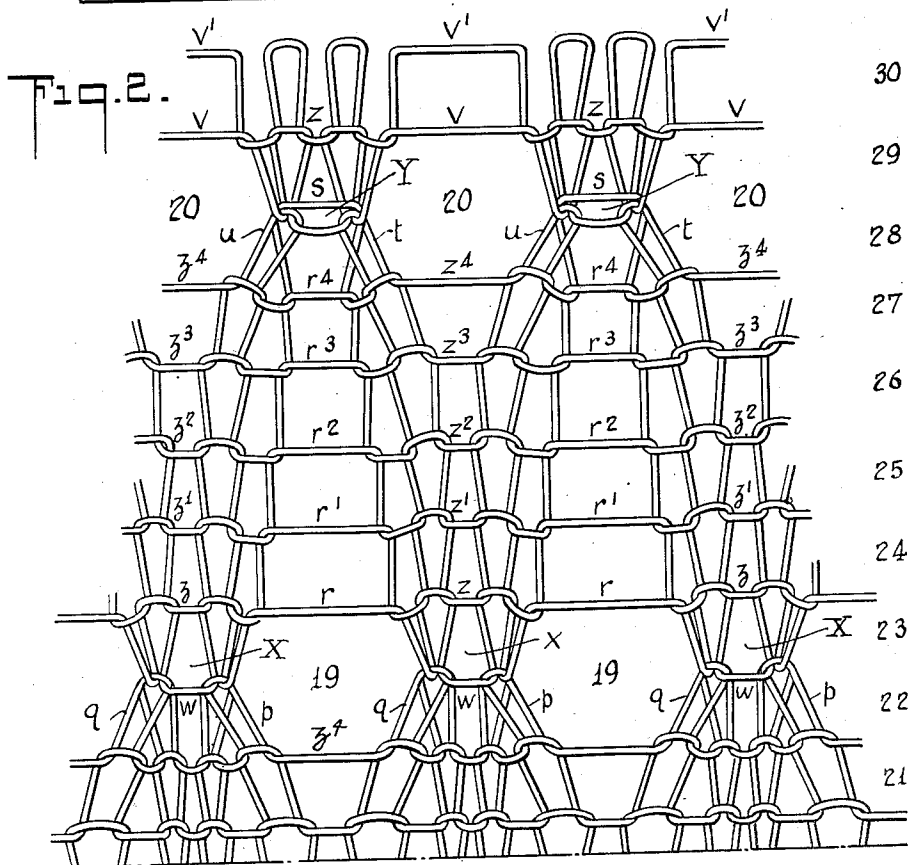
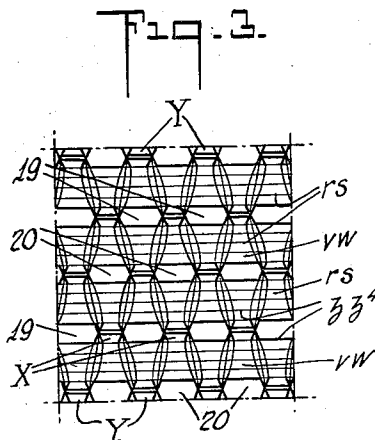
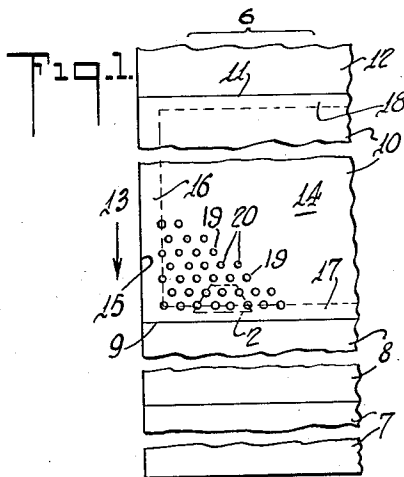
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HOSIERY WITH ELASTIC SECTION

Filed Aug. 15, 1939

2 Sheets-Sheet 1



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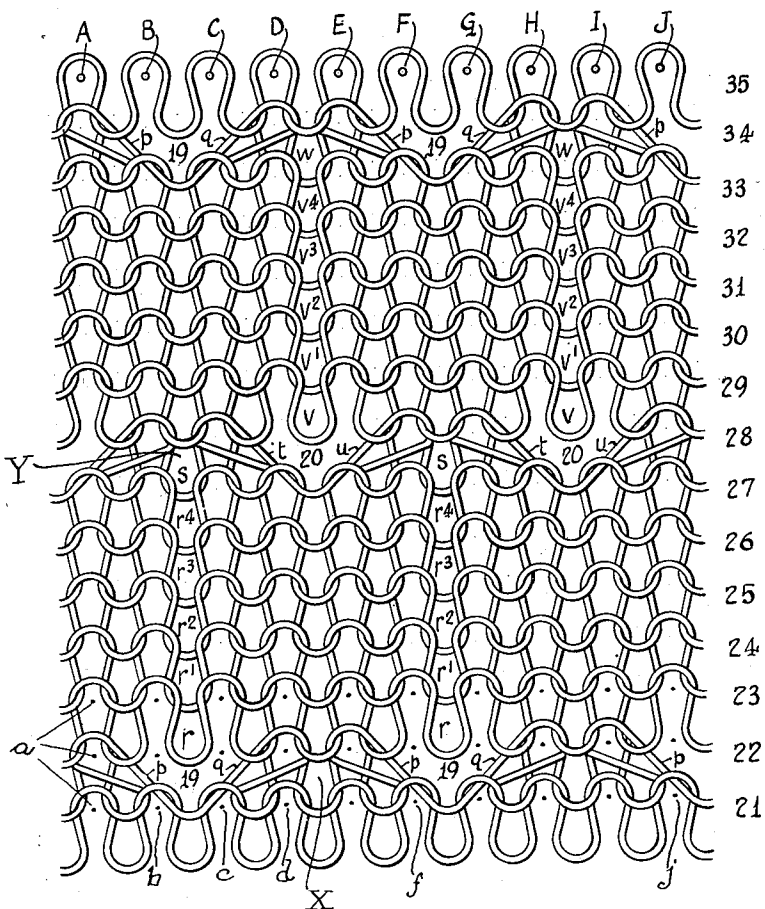
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Fig. 4.



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HOSIERY WITH ELASTIC SECTION

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This invention relates to hosiery with elastic section, having more particular reference to the providing in a knitted stocking or like article a transverse or circumferential section or stripe knitted from a stretchable or rubber yarn in distinction to the silk or other regular yarn of which the major part or body of the knitted article is composed; the invention having reference both to the method of knitting the stretchable stripe or section into the fabric and to the article or product consisting of the structure of knitted fabric containing such section or stripe.

The plan of incorporating integrally in a stocking a stripe or band of stretchable character, knitted from rubber yarn, affording yield to minimize injury to and tearing of the stocking and to facilitate movements of the limb is long well known, being disclosed for example as early as 1894 in the British patent of Michaelis No. 2,668 of 1894. The elastic section or stripe may be placed above or below the knee or at other points of the stocking to afford the desired cushioning or yielding effect. Rubber yarn of fine gage adapted for such purposes is long well known, for example a marketed yarn disclosed in the patent of Adamson No. 1,822,847 of September 8, 1931 being a yarn wherein the stretchable filament of rubber has a covering of fibrous material, such as silk of the same color as the body or adjacent parts of the stocking.

The general object of the present invention is to afford a knitted product, and a method for knitting the same, of the kind referred to, which will possess an ample and satisfactory capacity for elastic yield in both the longitudinal direction, that is, lengthwise of the wales and of the progress of the knitting, and transversely, that is, in the direction of the courses of the fabric. A further object is to afford such a method and product well adapted to economical and convenient knitting, by means of picot or lace attachments or other known means applicable to conventional hosiery knitting machines. A further object is to afford a fabric of the kind referred to which will be slightly not only when being worn and under stretch but also when relaxed. Further and more specific objects and advantages of the invention will be set forth in the hereinafter following description of an illustrative embodiment of the invention or will be understood by those conversant with the subject.

In the accompanying drawings Fig. 1 is a face view of a portion of a hosiery article or stocking blank comprising a stretchable section embodying the present invention; and this may be considered

as a top view of the lefthand portion of a part of the length of such a stocking, when lying flatwise, the top or welt end of the stocking appearing at the near side of the figure for convenience, since the fabric travels toward the observer in the usual process of knitting a stocking; the elastic section being shown in its unstretched or relaxed condition.

Fig. 2 is a diagrammatic face view of a small area of the elastic portion of the stocking fabric, not only an enlarged scale, but also with the fabric having been extensively attenuated or stretched in both longitudinal and transverse directions in approximately equal degrees to render perceptible the structure; the diagram of Fig. 2 representing an extent of area of Fig. 1 substantially as indicated by the bounding line 2 as marked on Fig. 1, and showing that side of the knitted fabric which usually becomes the inside of the completed garment.

Fig. 3 on a smaller scale than Fig. 2 shows a more extended area of the fabric and the relationship between its structural features.

Fig. 4 is a conventionalized diagram of the mode of looping of such a fabric as is shown in the other figures, being laid out mainly for the purpose of aiding a description of the steps by which the product or hosiery may be knitted; in some respects the illustrated disposition of the yarns being theoretical or explanatory, rather than actual.

Referring first to Fig. 1, a portion of a hosiery article or stocking 6 is shown, broken away at various points for condensation of the figure. The portion nearest the observer is the top of the stocking, preferably in the form of the usual welt 7, which may be of any desired length longitudinally of the length of the stocking, and of a transverse width corresponding of course to the desired circumference of the finished product. Beyond the welt, and knitted thereafter, is a section or area 8 composed of regular yarn, as silk, knitted in any conventional manner, as with regular looping. At the line 9 occurs a change or transition from regular yarn to elastic or rubber yarn, and a section or stripe 10 composed of elastic yarn appears on the figure, followed by a second transition line 11, beyond which follows the usual knitted fabric 12 to constitute the leg of the stocking.

The arrow 13 indicates the direction of travel of the fabric as the knitting continues, being toward the observer, so that the successive courses are produced at the far end of the figures, whereat

the needles are indicated in Fig. 4, the loop formation proceeding in that direction.

Referring in further detail to the elastic section or stripe 10, the main portion 14 of this area consists of mesh or openwork fabric. This mesh area may terminate somewhat short of the side edges or selvages 15 of the fabric, leaving a plain elastic margin 16 adjacent to each back edge. There is also shown an elastic margin 17 between the transition line 9 and the mesh area 14, and a similar margin 18 between said mesh area and the transition line 11. Lengthwise the stripe 10 may comprise from 30 to 60 courses more or less of elastic yarn in the openwork area 14, with a few plain courses in the margins 17 and 18; and the edge margins 16 may comprise from 5 to 20 wales, more or less.

The mesh or openwork area 14 of the elastic section is shown as formed with a regular system of eyelets or holes 19 and 20, these being staggered in alternate rows and forming a polkadot pattern. The detail structure of the area 14, and its mode of construction are illustrated respectively in Figs. 2, 3 and 4, and for convenience the steps of production will be first described mainly upon Fig. 4, with occasional reference to Fig. 2.

A reasonable number of needles, namely ten, are indicated by small circles A to J at the far end of the diagram Fig. 4; while along the wales in line with the respective needles are at some places indicated by round dots a, b etc. the relative needle positions in the needle loops of certain of the courses of the fabric. A sufficient number of courses is indicated, comprising courses numbered 21 to 35 inclusive, to permit an explanation of the complete cycle of knitting actions to construct a fabric according to Figs. 1 and 2. The courses may be considered as divided into a succession of groups, and there may be varying numbers of courses in each group, for example six, as shown, more or less. Thus one group of six courses commences with the special or transfer course 22 and terminates with course 27; the next group extends from course 28 to course 33. The characteristic operations are performed in each group in offset or staggered relation to those in the next preceding and following groups. A third group commencing with course 34 has its features staggered with relation to the second group, but preferably in line with the first group, so that the fabric main openings or eyelets 19 in the first and third groups are in alinement but are staggered with relation to the openings 20 in the second and fourth groups, and so forth, in correspondence with Figs. 1 and 2.

Referring to the diagram Fig. 4, with occasional reference to Fig. 2, the method hereof may be described as follows. After knitting course 21 of elastic yarn, being the last knitted course of the margin 17, the first course 22 of the group 22-27 is laid and sunk in the regular manner, and knitted in or looped through the loops of the preceding course; and the knitting is now suspended for purposes of effecting transfers in special course 22. It is to be understood that in changing from silk to rubber yarn any necessary adjustments are to be made due to the difference in the materials; for example the tension is usually much reduced to minimize stretch during knitting, especially as sinking and other operations tend to increase the initial stretch in the looped course.

The transfer operations at course 22, and corresponding subsequent courses, may be performed by means of conventional lace or picot attach-

ments, and these mechanisms may give regular operations under cam control, or may be controlled by Jacquard. The means used for these transfers are not herein disclosed as those conversant with the art will understand the appropriate means to use for carrying out the method steps and producing the resulting fabric as herein disclosed. Each course herein produced by loop transfers such as described may for convenience be referred to as picot or transfer courses, the transfers serving to eliminate certain regular loops in the production of openwork fabric.

As shown, the operations at transfer course 22 are as follows, the picot bar being assumed to carry transfer points spaced for every fourth needle, for example. From needle B the loop is transferred leftward to needle A, and similar leftward transfers are at the same time made from certain other wales or needles across the width of the fabric, in the illustrated case from every fourth needle, so that the loop on needle F is transferred leftward to needle E, that on needle J leftward to needle I, and so forth. All of these leftward transfers are simultaneously performed by the spaced picot points during dipping and transfer motions of the picot bar. The same picot bar and points may then be operated by further dips and shifts to complete the transfer operations at course 22, by analogously removing the loops from needles C, G, K etc. and transferring them rightwardly on to needles D, H etc. The transfers are from pairs of adjacent needles and to other pairs of adjacent needles, so that in this instance every needle is concerned. The loops thus transferred leftwardly at course 22 are all designated p and those transferred rightwardly are designated q. These transfers are indicated on Fig. 3 at course 22, and twelve courses or two groups beyond similar transfers of loops p and q are indicated, in alinement with those at course 22. In each case these operations, taken with those on the next succeeding course 23 or 35, form the large mesh spaces or holes 19.

The transfers at course 22 being completed knitting is resumed, the next elastic yarn course 23 being laid and sunk, providing a course of needle loops some of which are drawn through the previous loops. The action is regular excepting that between needles B and C, and between F and G, etc., whereat the previous course has no needle loops, there is produced a reverse or sinker loop r, preferably defined by a dividing sinker, which loop is unattached to the previous course and therefore with the extraction of the sinker becomes loose, free or floating. For descriptive purposes each of the floating loops r is shown on the diagram in a theoretical position, being the position such as it might have had if looped into the previous course, although, since the previous loops on needles B and C etc. have been transferred left and right respectively, producing the holes 19, the sinker loops r are left unsupported; from which it is clear that upon the retraction of its sinker what actually happens is that the reverse loop r is immediately released, and straightens out and disappears as a loop, becoming the mere bar or rung r of Fig. 2. The several slackened and straightened loops or bars r of course 23, at every fourth wale, cause the course to readjust itself and relax, passing straightly behind needles BC and FG etc. while looped upon the remaining needles.

These operations at courses 22 and 23 may be traced upon the actual fabric, with a final disposition of the yarns as shown in Fig. 2. The

straightening out of the yarn of the loops r affords the far boundary of the large eyelet openings 19, which are otherwise bounded by other portions of the yarn of courses 22 and 23, including loops p and q , as plainly indicated, and may assume the hexagonal shape shown. These operations cause the yarns of these two courses, between each two mesh openings 19, to assume a close or central concentration of yarns, like a ganglion, and which for convenience will be termed a nucleus X. These nuclei are alternated with the mesh holes 19 along the combined courses 22 and 23; and in the next succeeding group of courses, as shown, there will be a series of similar nuclei Y between the hexagonal openings 20 at combined courses 28 and 29. To the left and right of each nucleus X or Y are mesh openings; beyond each nucleus is a longitudinal area of plain knit fabric, and leading up to each nucleus is an open structure of bars r , r' etc. which may be described as a ladder; these combined structural elements constituting a characteristic basis of the fabric of the present invention.

Returning to Fig. 4, it has been explained that during the actual knitting at course 23 each sinker loop r has immediately relaxed, straightened out and disappeared upon the retraction of the sinkers, the yarn taking a disposition substantially as shown in Fig. 2, before the laying of the next course. The sinker loop in straightening extends back of both of needles BC and FG etc., thence passes into looped engagement with a double loop of course 22, at each side, and thence back and around needles A, D, E, etc. The result is, at each nucleus X, that six strands of course 23 yarn converge into each nucleus similarly to the convergence of strands of course 22 therewith.

The loop course 23 having been pulled through the loops of the special or picot course 22, as described, with the elimination of its loops upon needles B and C, the next succeeding course 24 is laid, sunk and knitted into the fabric. During these steps the reverse or sinker loops r' between needles BC and FG etc. in course 24 become free and detached with the retraction of the sinkers, thereby relaxing and straightening out similarly to loops r and for similar reasons, there being no loops upon needles BC, FG etc. in course 23. The knitting then proceeds with courses 25, 26 and 27 in a similar manner, each of the sinker loops r^2 , r^3 and r^4 disappearing in a similar manner, and each as soon as it is formed, Fig. 2 showing that they become straight bars, the bars r to r^4 resembling the rungs of a ladder converging as it progresses, along and between needles or wales B and C etc. To make more clear that the sinker loops and bars r , r' , r^2 etc. are formed independently and are at no time interlooped with each other, Fig. 4 shows each sinker loop r , r' etc. as out of locking engagement with the others. In fact each has straightened and disappeared before the next has been formed, the drawing being merely explanatory.

This described sinker loop relaxing operation is continued even into the first or special course 28 of the next group, so that each sinker loop s thereof between needles BC and FG etc. is similarly freed and relaxed, to disappear with the retraction of the sinker. Thus six sinker loops in the same wale are freed and relaxed in succession, each one as it is formed and before the next one is formed. The result of these actions, in line beyond each mesh hole 19, is to produce

the separate cross bars r , r' , r^2 , r^3 , r^4 and s , forming as a whole what may be termed a ladder rs , extending from the first bar r thereof at course 22 to the corresponding bar at course 28.

Now, the operation at course 28 is different from that at courses 23 to 27 since each sinker loop s is part of a nucleus Y at course 28, which is staggered in relation to nuclei X. The nucleus Y in fact comprises loops laid on needles BC and loops transferred from adjacent needles 10 to needles BC. The retraction of sinkers and relaxing of sinker loops s occurs before the transfers are made at course 28, thereby furnishing loose yarn which is largely taken up by these transfers, and in fact facilitates and improves the transfers. With the formation of each nucleus Y naturally the freeing and disappearing of sinker loops of the series r — s between needles BC etc. ceases, and the corresponding actions in the next group of courses 28 to 33 commence at a new point, namely between needles DE etc., and along wale lines half way between those along which the previous actions proceeded.

As has been made clear course 28, the first of the group 28 to 33, is laid, sunk and looped through the previous course, and during a pause after the sinkers have retracted, is subjected to the following transfer operations, loops u from needles A, E and I etc. go rightwardly on to needles B, F and J etc., and loops t from needles D, H etc. leftward on to needles C, G etc., all in similar fashion but contrary arrangement to the transfer at course 22. Thus the basis is laid for the construction of the nuclei Y at the ends of the ladders rs and the large mesh openings 20 between needles D and E etc.

Course 29 is then laid, sunk, looped into the fabric and disposed in the manner already described in relation to course 23, each of the sinker loops v in course 29 being freed due to the absence of the two previous loops causing the presence of the mesh holes 20, and promptly straightening out upon the extraction of the sinkers and the pulling of the adjacent loops through the fabric by the needles. Similar manipulation and disposition of the yarn in courses 30, 31, 32 and 33 takes place, each of the sinker loops v^1 , v^2 , v^3 and v^4 becoming freed and straightening out as already described, forming a series of cross bars as partially shown on Fig. 2, such bars constituting ladders v w each of which terminates with the sinker loop or bar w of the next transfer course 34. The next following group of courses 34 etc. comprises nuclei X and mesh openings 19 staggered with relation to the meshes Y and 20, but in longitudinal alinement with the still earlier nuclei X and meshes 19.

The several nuclei or focal points of the knitted web are relatively small, well separated and staggered, and between them are relatively large mesh eyelets in each row, and between rows a normally-relaxed structure of the elastic yarn; the whole constituting a fabric freely stretchable in both longitudinal and transverse and hence in all directions. Fig. 3, on a scale between those of Figs. 1 and 2, shows a more extensive area of the fabric, with its loose and open features of structure between its focal concentrations or nuclei X and Y, spaced and staggered.

By these steps and method a knitted article or stocking is produced comprising elastic fabric, in a section or stripe, wherein, in each of several successive groups of courses of the elastic yarn two initial or adjacent courses, namely the first

two, as 22 and 23, are caused, by loop transfer and yarn readjustment, to contain a transverse series of mesh holes or eyelets separated by yarn nuclei, the holes and nuclei of the successive groups of courses being relatively staggered, and the fabric beyond each mesh hole comprising a ladder of successive bars of relaxed elastic yarn terminating at a nucleus in alinement with such hole.

In constructing such a fabric in the manner described an interesting formation was found to occur in the structural result, shown on the Fig. 2 diagram, prepared from a photographic enlargement of a stretched area of fabric. The sinker-created slack beyond each mesh hole or eyelet not merely produces the bar series or ladders r s beyond eyelets 19 and similar ladders v w beyond eyelets 20, but the slack is able to reach right and left beyond these ladders, well into the adjoining fabric, due largely to the fact that each slack is afforded immediately by the retraction of the sinkers at each course before even the next succeeding course is laid. This causes to be produced what may be termed a system of secondary ladders, each composed of a series of yarn bars z , z^1 , z^2 , z^3 and z^4 , as shown, in line with and beyond each nucleus; resulting in the formation of a ladder z z^4 extending from each nucleus X or Y to a mesh hole 20 or 19 beyond. Moreover, since the ladders r s converge in the direction of knitting, because the bars naturally grow shorter towards each nucleus, it results that more and more slack yarn is rendered available for right and left adjustment in each course as the knitting proceeds from course to course, so that the secondary or reversed ladders z z^4 are caused to diverge, the bars growing longer and longer in the direction of the knitting. A balanced and slightly fabric results, as shown. Each eyelet 19 or 20 is bounded at its near side by the quite long ladder bar z^4 , approximating the length of the bar r or v at the opposite side of the eyelet, so that each eyelet takes a fairly symmetrical hexagonal shape, the transferred loops in the adjacent nuclei affording the inclined sides completing each hexagon.

The final fabric therefore may be described as comprising, at the two courses 22 and 23 the hexagonal eyelets 19 alternated with nuclei X; followed by several courses, four being shown, embodying the tapered or converging ladders r s beyond each eyelet and the flared or diverging ladders z z^4 beyond each nucleus, with small inclined units of regular fabric, two loops wide, beyond each two ladders; the next two courses 28 and 29 having a structure similar to that of course 22 and 23, but staggered as explained; and the next four courses 30—33 being analogous to courses 24 to 27; thus completing a cycle of twelve courses, which may be repeated as far as desired through the length of the elastic fabric. Fig. 3 shows this specific principle of structure.

The readjustment of the slackened rubber yarn at each course is thorough due to the fact that the sinker loops are relaxed progressively and independently, as each course is formed. Each of the ladders of relaxed yarn bars is completed before further extension of the relaxing action is terminated by the loop transfers of the next course beyond. Each of the loop transferring actions, staggered in the successive groups, performs the twofold function of terminating the ladder formations of the previous group, and starting the ladder formations of the following group.

The described fabric structure possesses superior yield in both longitudinal and transverse directions. This results from the fact that the mesh holes or eyelets 19 and 20 are staggered over the whole area of the stripe, giving a balanced two-way yield or stretch. The entire area may be knitted solely of elastic yarn, for the same reason, and there is no need of introducing courses of regular yarn interrupting the structure of the elastic fabric. The only thickened parts of the structure are the small staggered nuclei X and Y, and Fig. 3 shows that these are wholly spaced apart and disconnected from each other except in the sense that each nucleus constitutes a center of radiating openwork features, the eyelets and the ladders.

While a specific embodiment has been shown by way of illustration of the principles of the present invention it is not intended to limit the scope of the invention to the details thereof since many matters of method, step, arrangement and construction may be variously modified without departing from the novel principles involved, and no limitation is intended except as set forth in the appended claims.

What is claimed is:

1. A knitted article comprising elastic fabric wherein, in each of several successive groups of courses of elastic yarn, two adjacent courses, by loop transfer and yarn readjustment, comprise a transverse series of yarn nuclei alternated with mesh holes, and the nuclei and holes in each of the groups of courses being staggered relatively to those of the preceding and succeeding groups, and the fabric beyond each mesh hole comprising a converging ladder of successive bars terminating at a nucleus in alinement with such mesh hole.

2. A knitted article of hosiery having areas composed of regular and elastic yarn respectively and comprising an elastic section or stripe wherein, in each of several groups of courses, the first two courses, by loop transfer and yarn adjustment, contain a transverse series of mesh holes or eyelets separated by yarn nuclei, the holes and nuclei of the successive groups of courses being relatively staggered, and the fabric beyond each mesh hole comprising a ladder of successive bars of relaxed elastic yarn terminating at a nucleus in alinement with such mesh hole.

3. An article as in claim 2 and wherein the ladder from each eyelet to a nucleus is converged by progressive shortening of bars, and there extends from each nucleus to an eyelet a secondary ladder which diverges by progressive lengthening of bars.

4. A knitted hosiery article with an elastic section or stripe for two-way yield in wear, wherein the elastic section consists of several successive groups of courses, the initial courses of each group containing a transverse series of eyelets separated by yarn nuclei, each such nucleus comprising a portion of yarn of one course with two needle loops therein transferred toward each other and that portion of the yarn of the next course which is looped with said transferred loops, the eyelets and nuclei of the successive groups of courses being relatively staggered, and the fabric beyond each eyelet comprising a ladder of successive bars of relaxed elastic yarn terminating at a nucleus in alinement with such eyelet.

5. A knitted stocking containing an elastic section or stripe for two-way yield in wear, said elastic section consisting of several successive

groups of courses of elastic yarn, a pair of courses of each group containing a transverse series of eyelets alternated with yarn nuclei, each such nucleus comprising a portion of the yarn of the first course of said pair wherein two needle loops are transferred toward each other and comprising also that portion of the yarn of the next course which is looped with said two transferred loops; and the fabric beyond each eyelet comprising a ladder of successive transverse bars of relaxed elastic yarn terminating at a nucleus in alignment with such eyelet.

6. A stocking as in claim 5 and wherein the fabric beyond each nucleus comprises a secondary ladder of transverse bars of relaxed yarn, and each eyelet is substantially hexagonal, with its far and near sides consisting respectively of the first bar of the primary ladder, and the last bar of the secondary ladder.

7. A stocking having areas knitted of regular yarn and a section of elastic yarn; wherein the elastic section has a structure comprising a staggered system of relatively small and well-separated nuclei or focal points of elastic yarn, arranged in rows, with relatively large mesh openings between the nuclei in each row, and a knitted web of normally relaxed elastic yarn between rows, comprising a system of ladders each commencing beyond a mesh opening and extending to and being stopped by a nucleus.

8. A stocking having areas knitted of regular yarn and a section of elastic yarn; wherein the elastic section has a structure comprising a series of rows of large mesh openings arranged in staggered relation and separated by focal concentrations containing transferred loops, and ladders of rungs of relaxed elastic yarn beyond each mesh opening each extending to and terminating at one of said focal concentrations.

9. The method of knitting hosiery with elastic section, comprising in each group of a series of groups of courses, the steps of knitting in the first group a first or transfer course of elastic yarn and while its loops remain on the needles transferring periodic loops thereof alternately leftward and rightward to produce alternating double-loop nuclei and eyelet openings, knitting in such group a second yarn course during which the sinker loop between each pair of needles from which loops were transferred in the first course is caused to relax and straighten with the extraction of sinker and its yarn to become readjusted along said second course, knitting the remaining courses of such group in manner similar to the second course during which the yarn of the corresponding sinker loops relaxes and straightens in each course as formed, thereby producing a series of relaxed yarn bars beyond and in line with each eyelet opening, knitting and effecting transfers in the first course of the second group in manner similar to the

knitting of the first course of the first group but in staggered arrangement so that each nucleus of the second group is in alignment with an eyelet of the first group and terminates the series of yarn bars therebeyond, and continuing similarly with the second and further groups of courses.

10. The method of knitting hosiery with elastic section, comprising in each group of a series of groups of courses, the steps of knitting a first or transfer course of elastic yarn and transferring periodic loops thereof alternately leftward and rightward toward and from adjacent needles, then knitting a second yarn course during which the sinker loop between each pair of needles from which loops were transferred in the first course is caused to relax and straighten with the extraction of sinker and its yarn to become readjusted along said second course, whereby said first and second courses combined are caused to contain alternating nuclei and eyelet openings of two-course width, knitting the remaining several courses of the group in manner similar to the second course during which the yarn of the corresponding sinker loops relaxes and straightens in each course as formed, thereby producing a series of relaxed yarn bars beyond and in line with each eyelet opening, knitting the first course of the next group and transferring loops thereof in manner similar to the knitting of the first course of the previous group but in staggered arrangement so that each nucleus of the second group is in alignment with an eyelet of the first group and terminates the series of yarn bars therebeyond, and continuing similarly with said next group and further groups of courses until the desired extent of elastic fabric is knitted.

11. The method as in claim 10 and wherein in each transfer course, the relaxing of sinker loops precedes the transfers, thereby facilitating the transfers and the readjustment of yarn in said course.

12. The method as in claim 10 and wherein the operations upon the first and second courses of each group are such as to produce eyelets of hexagonal shape and intervening nuclei of double X shape.

13. The method as in claim 10 and wherein the series of relaxed bars beyond each eyelet form converging ladders, the bars becoming progressively shorter toward the nucleus beyond.

14. The method as in claim 10 and wherein the series of relaxed bars beyond each eyelet form converging ladders, the bars becoming progressively shorter toward the nucleus beyond, and there is formed beyond each nucleus a ladder of yarn bars becoming progressively longer toward the eyelet beyond.