Nov. 29, 1960 S. O. B. LJUNGBO 2,962,384

RUN-RESISTANT KNITTED STOCKING

Filed June 27, 1957

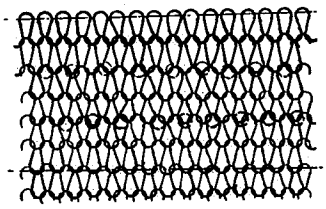


FIG. 1

FIG. 2

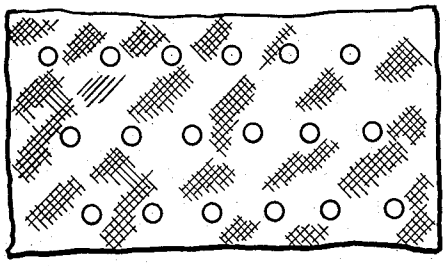
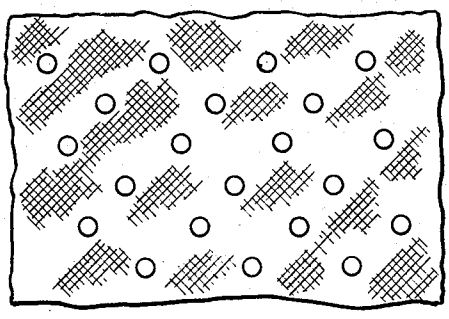


FIG. 3



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2,962,384

RUN-RESISTANT KNITTED STOCKING

Sven Olof Birger Ljungbo, Upplandsgatan 49, Stockholm, Sweden

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6 Claims. (Cl. 117—38)

The present invention has for its object a method of rendering a knitted fabric, e.g. a stocking of normal hosiery type, resistant to runs, such stockings as are, for example, not finished by sewing together being also intended to be treated.

It has been known before to render such stockings resistant to runs e.g. according to Swedish Patents Nos. 98,738 and 109,629, U.S. Patents Nos. 2,308,593 and 2,388,144 and French Patent No. 891,854.

According to the first-named patent, an adhesive material is applied to stockings in the form of straight or zigzag lines forming inclined angles with the courses. A disadvantage of this method is that the adhesive applied appears as a clearly visible pattern on the stocking, which in most cases is considered a blemish. Another disadvantage is that the stocking acquires uneven elasticity in different directions.

Substantially the same considerations may be applied to U.S. patent specification No. 2,388,144 which also describes a knitted fabric with improved resistance to runs. According to this patent specification the adhesive is applied on, or adhesion is effected between, two threads lying one above the other within rectangular regions of the stocking of some length, adhesion taking place along parallel lines diagonal relatively to the length of the stocking, which are subdivided into two groups, one group of lines forming substantially right angles with the other group. By this arrangement of the adhesive material on rectangular regions of some length the adhesive material appears as a clearly visible pattern on the stocking, and this will thereby acquire a disadvantageous uneven elasticity in different directions.

The second-named Swedish patent has for its object a method of applying the adhesive material by spraying an adhesive solution dispersed in air, e.g. by a spray nozzle. A disadvantage of this method is that it cannot be prevented that all parts of the fabric of the stocking undergo treatment. Even if it can be avoided according to the patent specification that the adhesive solution forms a coherent layer or a film on the fabric of the stocking, the elasticity of the latter is reduced by this method to only a fraction of what it was before treatment.

U.S. patent specification No. 2,308,593 relates to a method in which a yarn is spun from at least two different fibre types having different solubility properties in certain solvents. Out of this yarn a fabric is knitted, e.g. a stocking, which is thereafter treated with one or more solvents dissolving one of the fibrous materials but not the other. The treatment is so carried out that the fibres in question are not wholly dissolved but only become sticky on their surfaces. At the crossings between the threads of the fabric where two such fibres are lying adjacent to each other, they will stick together. In this way the threads get stuck together at such crossings but not at the others. A stocking treated in this way obtains a cerain resistance to runs without its elasticity being lost to any greater extent. Provided the quantity of thread in each mesh was constant, there would also be

a possibility of producing a fabric with a desired number of stuck-together thread-crossings per unit area by varying the twine and the proportion of soluble to insoluble fibres. This, however, is not the case, but the quantity of thread per mesh varies somewhat even with the most closely controlled knitting machines. Owing to this fact no even and controlled distribution over the area of the knitwork is obtained of the stuck-together thread points. This results in the possibility of certain parts of the knitwork, where the stuck-together points are too sparse, having bad resistance to runs, whereas on the other hand the elasticity may be reduced too much in those parts where the density of the stuck-together points has become too great. Owing to the twist of the thread during knitting being beyond control it is, moreover, not possible and would not be, even if the quantity of thread per mesh was constant, to displace the sticking-together points sideways from one course to another so as to obtain a complete coverage of the whole width of the knitted fabric with one sticking-together for each course. Resistance to runs thus becomes a matter of chance, and incomplete.

French patent specification No. 891,854 refers on the one hand to an adhesive composition for treating fabrics for stockings and on the other hand to a method of treating such fabrics. In this treatment, the adhesive material is placed in a ring or circle round the parts of the stocking which are most delicate according to the patent specification, viz. round the hollow behind the knee and round the projecting part of the foot at the ankle. Should a run start somewhere between these two sections, it will run on until it reaches them, and resistance to runs cannot, therefore, be obtained according to this method between the lines referred to above. It is clearly stated in the patent specification that the adhesive material is to be put on in the form of a ring or a coherent band at the locations stated above, as a consequence to which the sideways elasticity must be lost.

The inconveniences referred to above in the treatment of a knitted fabric, e.g. a stocking, with a view to rendering it resistant to runs by application of an adhesive material capable of gluing the fibrous material therein, are overcome according to the present invention by effecting gluing at a number of spots or small elemental areas which have substantially equal extensions in all directions, said spots or elemental areas being substantially uniformly distributed in an arbitrary way over the stocking, so that large areas not covered by the adhesive material do not occur on the stocking, the individual elemental areas being of such average dimensions and distribution that together they cover, within a desired area of the knitted fabric, the whole width of the knitted fabric or the chief part thereof. The uniform distribution of the elemental areas referred to is usefully effected in the form of a pattern, e.g. in the form of straight or crooked rows of spots or elemental areas, the rows of spots being preferably displaced sideways relatively to each other. By means of this arrangement of the adhesive material within elemental areas on the knitted fabric (stocking) according to the invention the knitted fabric is rendered resistant to runs, any change in the elasticity of the fabric being thereby the same in all directions.

Some examples of such patterns are represented in Figs. 1, 2 and 3. Fig. 1 shows a pattern of straight rows of spots with elemental areas which by way of example may be 0.5–1.0 mm. in size, this pattern being so arranged that two rows of spots together cover the whole width of the knitted fabric. Fig. 2 shows a pattern of straight rows of spots in which three rows together cover the whole width of the knitted fabric. Fig. 3 shows a pattern of crooked rows of spots in which three rows together cover the whole width of the knitted fabric. The spots or elemental areas may have the form of circles, ellipses of

a maximum proportion of long axis to short axis of about 2:1, rectangles of a maximum proportion between sides of about 2:1, triangles having a minimum angle of about 15°, polygons or the like. The elemental area should at most cover two adjacent meshes in the knitted fabric. According to the invention it is, however, not necessary that the pattern of spots should have a regular appearance. The only condition is that it should be of such a nature that within a desired section on the knitted fabric the width of the knitted fabric or the greater part thereof should be covered by points having adhesive material applied thereto.

In carrying into effect the method on stockings, which at present would appear the most important field of application, it is important that the applied adhesive material in the elemental areas, which form the spots according to what was explained above, should not form a coherent film covering the meshes but is only deposited round the threads and glues these to each other at the crossings. Otherwise a large number of glittering spots are obtained on the surface of the stocking, which is considered a serious blemish. It is true that such glitter can be avoided if the film has a dull surface, but in this case the meshes covered by the film appear as white or coloured dots, which is also considered a blemish.

The condition last referred to is fulfilled according to the invention by applying the adhesive material for example in the form of a solution, a vigorous air current being blown or sucked through the fabric during or after the supply of the adhesive, preferably by jerks, so that the adhesive is fixed firmly to the fabric, also on the back thereof. This blowing or sucking action, which results in the removal of any adhesive films that may have formed, may possibly be effected through those points only of the fabric where the adhesive has been applied.

Adhesive films that may have formed may also be removed by pressing the knitted fabric, e.g. the stocking, against a porous bed, e.g. felt, filter paper, velvet or the like, possibly in the form of felt-clad rollers.

Another condition is that the application of adhesive is effected in such a way that the pattern of spots is distinct. Otherwise, i.e. if the areas carrying adhesive are allowed to spread over a larger surface than was intended for the pattern in question, the elasticity of the stocking is reduced too much by a too large percentage of the thread crossings being firmly glued together.

The adhesive material is applied, e.g. by a spatula through the holes in a stencil plate which is laid on the smoothed-down knitted fabric, a fabric lying snugly against a metal wire cloth or the like being placed beneath the knitted fabric, air being sucked down through the meshes of the metal wire cloth into one or more sucking boxes placed underneath. The sucking boxes may be replaced, as indicated above, by a porous or adherent fabric or like bed, such as felt, velvet, filter paper or the like, against which the stocking is pressed by a roller or cushion. So that the adhesive should be able to be applied more homogeneously to the knitted fabric in the holes of the stencil plate referred to, a thin, relatively coarse, gauze fabric is preferably employed between the stencil plate and the knitted fabric. Alternatively, the stencil plate may be of the silk screen type.

When treating stockings, the stocking is blown up after application of the adhesive so that its sides are separated, whereafter it is dried at room temperature or at elevated temperature, possibly after pulling it over a former or smoothing it down.

The method may also be carried out continuously by giving the metal wire cloth, stencil plate and textile fabrics the form of endless bands running over rollers, the knitted fabrics being placed on the lower textile fabric situated on the metal wire cloth, being conveyed between the textile tape situated below the stencil and the stencil itself with its upper textile tape, if any, and having the adhesive solution applied thereto through the stencil by means of a fixed stripper or roller, under or immediately behind which the sucking box for effecting the sucking-through of air is situated. The adhesive material may, as stated above, be supplied in the form of a solution, and in this case a spray nozzle may also be used for applying it. Alternatively, the adhesive material may be powdered or dusted over the stencil provided with holes, whereafter the stencil is removed and the fabric is put or pulled over a warm stocking former so that the adhesive material melts and the gluing effect is obtained. The method last referred to may also be carried out continuously.

In order to obtain such a distinct pattern in an effective way the methods known in the graphic industry are preferably used. Here, the adhesive solution is supplied by means of a photogravure or letterpress printing roller provided with the pattern of spots and having the adhesive solution applied thereto. In the application of this method to the treatment of stockings the stocking is pulled over a thin, smooth, plane stocking former, whereafter the pattern of spots is pressed on to both sides of the stocking, and films of adhesive, if any, are torn up, by guiding the stocking between felt-clad rollers.

In the method of application referred to above the adhesive was in all cases exclusively supplied in the form of a pattern of spots of a configuration predetermined from the start. It is, however, also possible to supply the whole surface of the stocking with an adhesive solution, whereafter the gluing of discrete spots is produced by pressing the stocking against devices such as rollers provided with a pattern of spots consisting of projecting parts, heated parts or parts covered with a hardener or other catalyst, whereafter the parts of the stocking not glued are treated to remove the adhesive solution therefrom.

For the supply there is used, according to the invention, a liquid product containing at least one solvent for the "plastic," i.e. the fibre material, at least one liquid not being a solvent for the plastic (diluent) and at least one polymer, insoluble in water, which is miscible with the plastic and soluble in the solvent, a solvent being employed whose evaporation speed is so much lower than the evaporation speed of the diluent that the main part of the solvent supplied is left on the plastic fibres after the diluent has evaporated therefrom, that, further, the diluent is used in such small quantity in the liquid product that not even after evaporation of the diluent it is able to cause a mixing or welding-together of the polymer present on the surface of the fibres with the plastic material in the fibres, and that the plastic fibres in the knitted fabric are, after evaporation of the diluent from the fibres, exposed to a raised temperature, whereby such a mixing or welding-together will take place with the co-operation of the small quantity of solvent left behind and substantially without the plastic fibres being weakened. Alternatively, the plastic fibres in the knitted fabric need only be dried for welding-together to take place. By "miscible with" is meant that the two polymers, i.e. the fibre material and the high polymer supplied thereto, do not precipitate each other's solutions. The liquid product may be formed by a homogeneous solution, as the diluent is miscible with the solvent for the plastic and this liquid mixture in turn constitutes a solvent for the polymer. The liquid product may also, for example, be formed by an emulsion or suspension of the polymer in a mixture of the solvent and the diluent miscible therewith. In evaporating the diluent, the fibres or fabrics treated are preferably heated to a temperature of up to 150° C., preferably to 130–140° C. When treating a polyamide fibre there is, according to the invention, supplied a product containing polymethyl or polybutyl methacrylate or a co-polymerization product of the monomers forming these polymers. If the polymer is formed by a polyvinyl acetal, e.g. polyvinyl formal or polyvinyl butyral, an acid is used as the solvent, the solution also containing an aldehyde, preferalby the same aldehyde as is present in the acetal.

Alternatively, a polyamide fibre in the knitted fibre may for example be provided with a polyacetal by treating the fabric with an aqueous solution containing polyvinyl alcohol and an aldehyde together with an acetalizing catalyst. The concentration of the starting material preferably amounts to 20–50%. Hardening is carried out at over about 100° C. and depends on the concentration of the solution. In this case the spotwise hardening on the fabric is preferably carried out with a roller provided with projecting parts.

Below are given some examples of compositions suitable for carrying out the method according to the invention, "parts" meaning parts by weight.

Composition 1:
- 14 parts of the co-polymerization product of methyl and butyl methacrylate
- 3 parts of cresol
- 3 parts of benzoic acid
- 21 parts of benzene

Composition 2:
- 84 parts of a 50 percent emulsion of polybutyl methacrylate in water mixed with:
  - 9 parts of cresol
  - 9 parts of benzoic acid
  - 0.6 parts of sodium lauryl sulphate
  - 0.2 parts of sodium alginate
  - 27 parts of water

Composition 3:
- 25 parts of a 40 percent emulsion of polymethyl methacrylate in water mixed with:
  - 3 parts of cresol
  - 3 parts of benzoic acid
  - 0.6 parts of sodium lauryl sulphate
  - 85 parts of water

Composition 4:
- 15 parts of polyvinyl formal
- 9 parts of acetaldehyde
- 25 parts of acetone
- 51 parts of formic acid

Composition 5:
- 15 parts of polyvinyl butyral
- 16.5 parts of butyraldehyde
- 17.5 parts of acetone
- 51 parts of formic acid

Composition 6:
- 12 parts of polyvinyl alcohol
- 4 parts of formaldehyde
- 7 parts of maleic acid
- 77 parts of water

By using the compositions detailed above, attack of the thread in the knitted fabric by the solvent, and consequent weakening of the thread, is avoided.

When using polyvinyl acetals, trouble arising from their sensitivity to water is reduced by the compositions detailed above containing an aldehyde.

The methods according to the invention will now be described in some examples of how it may be carried into effect, the invention, however, not being intended to be limited to such examples.

Example 1

Over the opening of a sucking box is stretched a fine mesh, fine thread metal wire cloth, e.g. wire gauze. On this is put a thin and not too dense fabric of, e.g., cotton, silk or other textile material. On top of this the stocking is then laid, properly spread out and smoothed down, so that it is free from creases. On top of this a stencil plate is laid from which the desired pattern of spots is stamped out. The stencil is tensioned so that it presses down the stocking and the fabric against the wire gauze. By means of a rubber spatula a suitable adhesive solution is then applied in a manner known from the silk screen method. By sucking air from the sucking box, a vigorous current of air is produced through the stencil holes while the adhesive solution is applied or, preferably, after it has been applied. This suction should not go on for a long time but should only take place in the form of one or more jerks or shocks. The method last referred to has proved most effective for tearing up films of adhesive which may have formed over whole meshes. The reason why the suction of air must not go on for any length of time is that the adhesive solution would thereby dry up whereby the two sides of the stocking would stick together, so that the stocking could then be opened only with difficulty. After air has been sucked through as stated above, the stencil plate is released, the stocking is taken out and is passed over a tube of about the same diameter as the cross section of the leg part of the stocking. Through this tube a vigorous air current is blown into the stocking so that its two sides are separated and the stocking is blown out. The blowing may either continue so long that the stocking is dried, or it may be interrupted before. In the last-mentioned case the stocking may be dried in a separately heated drying chamber or at room temperature. Alternatively, it may be passed over a heated stocking former so that the stocking is dried on this and is at the same time fixed in shape or smoothed out. During heating, the adhesive material may possibly at the same time be hardened, condensed, polymerized or made to under go some other chemical reaction. As material for the stencil, foils of certain plastics, e.g. polytetrafluoroethylene, polyethene, polyvinyl chloride etc., may be used. Instead of an open stencil, i.e. one with open holes, a stencil of the silk screen type may also be used in which the holes are covered by a gauze fabric. If an open stencil is used, it has been found advantageous to place a thin gauze fabric of relatively coarse mesh between the stencil and the stocking. A somewhat less conspicuous appearance of the glued points on the stocking is thereby achieved. This fabric may possibly be placed on top of the stencil plate.

Example 2

With the same apparatus as detailed in Example 1, the adhesive solution, instead of being applied by means of a spatula, is applied by spraying by means of a spray nozzle of the type used, e.g. in a paint spray pistol. When the adhesive is applied in this way, it is generally preferable to use an open stencil without the upper textile fabric or textile tape.

Example 3

On a sucking box covered by a wire gauze of the same type as described in Example 1, a stocking is placed, possibly slightly moistened by water or some other liquid, and on top of this is strapped an open stencil of the same type as described in Example 1. The suction of air is initiated, whereafter the adhesive material in pulverulent form is powdered or dusted over the stencil. The stencil is then removed and the stocking passed over a heated stocking former. The adhesive material will thereby be caused to melt down and the desired gluing effect will be obtained. Upon being taken off the former, the stocking is ready.

Example 4

The methods detailed in Example 1 may be carried out continuously, in which case the wire gauze, stencil and textile fabrics are shaped as endless bands running over rollers. The stockings are then placed on the lower textile fabric which is lying above the endless wire and are conducted by it in between the lower textile band and the stencil, or the upper textile band, coming from above. By means of a fixed stripper or a roller the adhesive solution is pressed through the stencil and the stocking. Below that roller or stripper or immediately following it there is provided a suction box or porous sucking fabric such as felt or velvet or the like which

causes the suction of air described above for tearing up any films of adhesive that may have formed across the meshes.

Example 5

The method may also be carried out continuously with the aid of a photogravure or letterpress printing roller provided with the pattern of spots desired, the adhesive solution being supplied to the roller in some known manner. When treating a stocking, this is preferably stretched over a thin, smooth and entirely plane stocking former, whereafter the stocking has applied thereto the adhesive material in the desired pattern of spots by means of the rollers. It is possible to press the stocking, after the supply of adhesive material, firmly against a felt-clad roller so that by suction any adhesive films that may have formed and which cover whole meshes are torn up. The stocking is subsequently dried, either while still on the former or after having been pulled off it, and has air blown through it.

Example 6

The treatment may also be carried out in such a way that the stocking is wholly impregnated with a solution containing condensable, polymerizable, vulcanizable or thermosetting materials, e.g. composition 6 described above. The excess of the impregnation solution is pressed off, e.g. between rubber rollers, the stocking is smooth down and any film over the meshes is torn up by vigorously blowing air through or by mangling the stocking between two rollers lined with porous material, e.g. with felt. Thereafter the stocking is laid on a soft support and treated with a metal roller provided with a projecting letterpress pattern of spots. The roller is heated and/or smeared with catalysts or reagents which cause the desired reaction in the solution on the stocking. By the treatment with the roller, the stocking is glued in dots according to the pattern of spots. Leftover unreacted solution is washed out of the stocking with water or some other suitable solvent.

Example 7

The treatment may also be carried out in such a way that threads first are covered with a solution containing adhesive material mentioned above and then are dried, a stocking or another knitted fabric being knitted thereof. The stocking is subsequently treated according to Example 6 with a roller provided with a projecting (letterpress) or countersunk (photogravure) pattern of spots or elemental areas. The roller is heated and/or

smeared with the solution or a catalyst or another reagent causing the layer of adhesive to be sticky or to be reacted chemically in the spots or within the elemental areas, the stocking being glued in the spots or within the elemental areas according to the pattern of spots or elemental areas.

What I claim is:

1. A stocking of the type knitted from threads of fibrous material and which is resistant to runs, said stocking being coated with an adhesive material capable of gluing the fibrous material in the stocking, said adhesive being applied to the stocking in small elemental areas which have substantially equal extensions in all directions and are substantially uniformly distributed in close spaced relation over the entire stocking, the individual elemental areas each extending over not more than two adjacent meshes in the knitted material and being limited to deposit around the threads.

2. A run-resistant stocking as defined in claim 1 wherein said small elemental areas of adhesive material are applied to said fibrous stocking material in spaced rows.

3. A run-resistant stocking as defined in claim 1 wherein said small elemental areas of adhesive material are applied to said fibrous stocking material in parallel spaced rows, the elemental areas of one row being staggered with respect to the elemental areas of an adjacent row.

4. A run-resistant stocking as defined in claim 3 wherein two adjacent rows of said elemented areas when considered together serve to cover substantially the whole width of the stocking material.

5. A run-resistant stocking as defined in claim 3 wherein three adjacent rows of said elemental areas when considered together serve to cover substantially the whole width of the stocking material.

6. A run-resistant stocking as defined in claim 1 wherein said elemental areas of adhesive material are applied to said fibrous stocking material in crooked rows and wherein three adjacent crooked rows of elemental areas when considered together serve to cover substantially the whole width of the stocking material.

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