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(54) **Mesh fabric for screen printing, process for preparing the same, gauze spanning method thereof and photosensitive film for screen printing plate by use thereof.**

(57) There are presented a mesh fabric for screen printing, which is a mesh fabric obtained by use of core-sheath composite filaments in which a component with lower melting point than the core is employed, characterized in that warp and weft threads are adhered to each other at the intersecting points of warp and weft threads by melting of the sheath component after fabrication to cover its surface integrally with the sheath components of the warp and weft threads, whereby the intersecting points of warp and weft threads are integrated on the surface with the warp and weft threads, a process for preparing a mesh fabric for screen printing, which comprises heating said fabric with a tension applied, thereby melting the sheath component of the core-sheath composite filaments to integrate it on the surface, a method for gauze spanning of a mesh fabric which comprises maintaining the tension of said mesh fabric at a value higher by 10 to 100% than the value of the tension during securing of said mesh fabric for 5 to 60 minutes, then releasing once said tension, and thereafter giving again a tension to have it secured onto the screen frame, and a photosensitive film for screen printing plate having a photosensitive agent layer or a photosensitive film layer laminated on a mesh fabric with the intersecting portions of both warp and weft threads being secured. Because, no deformation or slippage of threads occurs, the dimensional precision is high, and clear printing is possible even with extremely fine lines of some 10 microns, and also workability is good and also printing resistance is excellent.

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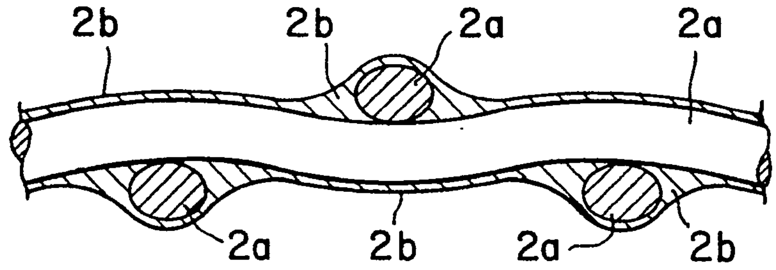


FIG. 2

MESH FABRIC FOR SCREEN PRINTING, PROCESS FOR PREPARING THE SAME, GAUZE SPANNING METHOD THEREOF AND PHOTOSENSITIVE FILM FOR SCREEN PRINTING PLATE BY USE THEREOF

BACKGROUND OF THE INVENTION

TECHNICAL FIELD

This invention relates to a mesh fabric for screen printing by use of core-sheath composite filaments to be used in print substrates, or plates for screen plating for other general uses such as printing, a process for producing the same, a gauze spanning method for gauze spanning thereof onto a screen frame and a photosensitive film for screen printing plate having a photosensitive resin coated or laminated thereon.

RELATED ART

In the prior art, screen printing plate has been prepared by forming a screen plate by plastering a mesh fabric (gauze) comprising a woven cloth such as silk, stainless steel, nylon, polyester, composite fibers of these under the state where a tension is given thereto, coating the screen plate with a photosensitive emulsion (direct method) or plastering a photosensitive film thereon (direct-indirect method) to prepare a photosensitive film for screen printing (PS plate) and subjecting the PS plate to exposure under the state with a posi-film pressed on the plate, or alternatively transferring an image obtained by subjecting a commercially available photosensitive film with a posi-film pressed thereon onto the surface of a mesh fabric (gauze) fixed on the above-mentioned screen frame.

Such mesh fabric of screen plate, unless spanned under an adequate constant tension, will suffer from distortion of the screen printed image, whereby no correct image can be drawn, it may be broken during transportation, or the image may be disturbed by peel-off of the photosensitive agent layer or the photosensitive film layer to shorten the life of the plate for screen plating. Therefore, there have been generally employed the gauze spanning methods such as "the direct drawing method" in which a mesh fabric is drawn up to a designated tension at once, or "the stepwise drawing method" in which it is drawn up stepwise from a relatively lower tension up to a designated tension.

Whereas, among the mesh fabrics (gauzes) to be used in such plates for screen printing, silk has problems in strength, dimensional stability, stainless steel has a problem in elastic recovery and yet both of these are expensive materials. Hence, fibers made of polyesters or nylons are now used in place of these. Particularly, mesh fabrics made of polyesters excellent in dimensional stability have been used in large amounts.

However, in screen plates comprising mesh fabrics of low mesh of 150 mesh or lower, due to small number of intersecting points of threads, mesh slippage is liable to occur and correct openings can be formed with difficulty. Therefore, for improving this point, a screen for textile printing by use of multi-filaments has been known in the art. However, such screen plate is fluffy and has the problem that finishing of printing is not good.

On the other hand, in mesh fabrics of 150 mesh or higher by use of monofilaments, due to many intersecting points of threads, although mesh slippage will occur with difficulty, no sufficient dimensional precision is obtained.

Accordingly, for improving such printing precision and printing resistance which are the drawbacks of the plate for screen printing of the prior art, it has been demanded to provide a novel mesh fabric having both the dimensional precision possessed by stainless steel fibers and the elastic recovery, etc. possessed by polyester fibers.

On the other hand, a mesh fabric prepared by thermal fusion of composite filaments with the core-sheath structure comprising use of a fiber having strength as the inner core with coating of a low melting point resin for the outside portion is described as useful for agriculture, civil engineering construction, industrial materials, miscellaneous goods for commodity uses in Japanese Laid-open Patent Publications Nos. 194221/1986, 162839/1989, 321947/1989.

However, there is no suggestion at all about the fact that the mesh fabric prepared by thermal fusion of these composite filaments with core-sheath structure can be used as the material of the plate for screen printing, and also there is nothing suggested at all about further lamination of a photosensitive agent layer or a photosensitive film layer on the mesh fabric.

SUMMARY OF THE INVENTION

The present inventor has studied intensively in order to solve the above-mentioned tasks, and consequently found that a screen printing plate formed from a mesh fabric obtained by fabricating core-sheath filaments comprising use of a component with lower melting point than the core for the sheath, melting the low melting component of the sheath of the filaments of said fabric by heating and adhering the intersecting points of warp and weft threads to have them integrated on the surface is free from deformation and slippage of warp and weft threads, whereby the dimensional precision is high and clear printing can be done thereon, and also workability is very good with excellent printing resistance, to accomplish the present invention.

More specifically, the mesh fabric for screen printing of the present invention is a mesh fabric prepared by use of core-sheath composite filaments by use of a component with lower melting point than the core for the sheath, characterized in that warp and weft threads are adhered to each other at the intersecting points of warp threads and weft threads by melting of the sheath component after fabrication, whereby the surface is covered integrally with the sheath component of warp threads and weft threads, thus having the intersecting points of warp threads and weft threads integrated with warp threads and weft threads on the surface.

The mesh for screen printing which is the second invention of the present invention a mesh fabric prepared by use of core-sheath composite filaments by use of a component with lower melting point than the core for the sheath, characterized in that warp and weft core threads are adhered to each other at the intersecting points of warp threads and weft threads by melting of the sheath component after fabrication, whereby the surface is covered integrally with the sheath component of warp threads and weft threads, thus having the intersecting points of warp threads and weft threads integrated with warp threads and weft threads on the surface.

The process for preparing the mesh fabric for screen printing which is the third invention comprises heating a mesh fabric obtained by fabrication of core-sheath composite filaments by use of a component for the sheath with a lower melting point than the core under the state with a tension of 0.7 g or more per denier applied in both warp and weft directions, thereby melting the sheath component of the core-sheath composite filaments to integrate it on the surface, followed by cooling.

The gauze spanning method of the mesh fabric for screen printing which is the fourth invention of the present invention is a method for gauze spanning of a mesh fabric for screen printing by securing a mesh fabric for screen printing having intersecting portions of both warp and weft threads secured by thermal fusion under the state with a tension given onto a screen frame, which comprises maintaining the tension of said mesh fabric at a value higher by 10 to 100% than the value of the tension during securing of said mesh fabric for 5 to 60 minutes, then releasing once said tension, and thereafter giving again a tension and maintaining it to the tension at the time of securing of said mesh fabric for 5 to 60 minutes, followed by securing of said mesh fabric onto the screen frame.

The photosensitive film for screen printing which is the fifth invention of the present invention comprises a photosensitive agent layer or a photosensitive film layer laminated on a mesh fabric having the intersecting portions of both warp and weft threads secured by thermal fusion thereon.

Effect

The mesh fabric for screen printing of the present invention which is a mesh fabric prepared by use of core-sheath composite filaments by use of a component with lower melting point than the core for the sheath, characterized in that warp and weft threads are adhered to each other at the intersecting points of warp threads and weft threads by melting of the sheath component after fabrication, whereby the surface is covered integrally with the sheath component of warp threads and weft threads, thus having the intersecting points of warp threads and weft threads integrated with warp threads and weft threads on the surface, can be made a mesh fabric (gauze) without mesh slippage, because the intersecting points of the mesh fabric are integrated by melting of the sheath component of the filaments constituting them. Therefore, there will occur neither deformation nor slippage of threads, whereby the dimensional precision is high and clear printing is possible even with extremely fine wire of some ten microns, and also workability is good with excellent printing resistance.

The mesh fabric of the present invention, although it is fusion adhered, has core threads present in warp and weft in shape of filaments, and therefore has adequate elasticity and enables preparation of a screen printing plate excellent in printing adaptability.

The mesh fabric for screen printing of the present invention prepared by heating a mesh fabric obtained by fabrication of core-sheath composite filaments by use of a component for the sheath with a lower melting point than the core under the state with a tension of 0.7 g or more per denier applied in both warp and weft directions, thereby melting the sheath component of the core-sheath composite filaments to integrate it on the surface, followed by cooling, can cancel substantially flexion of threads occurring by overlapping at the intersecting points of warp threads and weft threads inevitable in ordinary mesh fabric (this leads to deformation of threads during printing, namely lowering of printing precision) by melting the sheath portion of the core-sheath composite filaments under the state applied with a tension on both warp and weft of said mesh fabric to adhere the intersecting points of warp threads and weft threads, and fixing the fabric under a tension on both warp and weft, thereby forming a mesh fabric with very good precision.

Therefore, the mesh fabric obtained according to the process of the present invention can be made to have an appearance of a mesh structure as if prepared by resin molding with the intersecting points of warp threads and weft threads integrated on the surface, because the core threads of warp and weft are mutually adhered together at the intersecting points of warp threads and weft threads, and the sheath component of warp threads and weft threads covers integrally over the surface.

Besides, since the fabric texture as a whole is covered uniformly with the melt of the sheath component of the core-sheath filaments constituting it, the openings of the mesh are maintained uniform, whereby a screen plate with very good ink passability can be made.

Therefore, a mesh substantially without flexion in the threads (smooth fabric with the thickness being 1.7-fold or less, for example, 1.5-fold of the diameter of the thread employed) can be obtained, and therefore no deformation will be formed during printing. Accordingly, it becomes possible to prepare a screen very excellent in printing precision.

Concerning one for which still higher precision printing is demanded, the gauze spanning method as described below will be effective.

The method of gauze spanning of the present invention which comprises maintaining the tension of a mesh fabric with the intersecting portions of both warp and weft threads secured by thermal fusion at a value higher by 10 to 100% than the value of the tension during securing of said mesh fabric for 5 to 60 minutes, then releasing once said tension, and thereafter giving again a tension and maintaining it to the tension at the time of securing of said mesh fabric for 5 to 60 minutes, followed by securing of said mesh fabric onto the screen frame, can make the whole fabric of the mesh fabric again under the stretched state, and therefore a mesh fabric gauze spanned at a constant tension can be formed without leaving it to stand for a long time during gauze spanning.

Thus, the mesh fabric obtained according to the gauze spanning method of the mesh fabric of the present invention can be obtained with a stable shape, and therefore no substantial warp with lapse of time will be formed, and therefore the tension after gauze spanning can be stabilized within further shorter time than in the case of using ordinary mesh fabric and can be provided instantly for the preparation steps of screen printing plates (coating steps of photosensitive or heat-sensitive resin emulsion).

On the other hand, the photosensitive film for screen printing plate of the present invention obtained by laminating a photosensitive agent layer or a photosensitive film layer as such on the mesh fabric with the intersected portions of both warp and weft threads secured is not span on a frame, and therefore can be conveyed compactly by winding up or superposing it on one another, to conveyed easily, and screen mesh will not be broken or the tension force of the screen mesh spanned will not be relaxed during conveying. The durability of the plate is also high, and yet since it is spanned at the site of application, stretching or shrinkage of the plate film will occur with difficulty, whereby there is the advantage that a correct plate can be prepared, etc.

The screen printing plate by use of such mesh fabric has the intersecting points of composite filaments secured thereon, and therefore there is the advantages that a correct mesh is formed, that distortion will difficultly occur in the image printed, and that precise image can be drawn.

DETAILED DESCRIPTION OF THE INVENTION

[I] Composite Filament of Core-Sheath Structure

As the composite filament 2 of core-sheath structure to be used for the mesh fabric 1 for screen printing, as shown in a partially cut perspective view of the mesh fabric for screen printing of the present invention in Fig. 1 and in Fig. 2 which is a sectional view taken along the A-A line in Fig. 1, strong fibers are used for the innerside core portion, and the outside portion comprises the core structure portion filament 2a and the sheath structure portion filament 2b, and these can be fabricated into a mesh, then heated to melt the outside resin with low melting point and secured the intersecting portions of both warp and weft yarns by thermal fusion.

(1) Core structure portion filament

As the resin (first component) which can be used as the strong fiber with a high melting point to be used for the innerside core structure portion of the composition filaments of the above-mentioned core-sheath structure, there may be employed fiber-forming thermoplastic resins such as polypropylene, polyester or nylon-66.

Among these, polyamide or polyester fibers, particularly polyester fiber components with an ordinary to high viscosity having an intrinsic viscosity (η) of about 0.6 to 1.2 may be particularly preferably employed.

Specifically, there can be included polyester resins prepared by formulating aromatic dicarboxylic acids such as phthalic acid, isophthalic acid, naphthalene dicarboxylic acid, etc. and aliphatic or alicyclic diols such as ethylene glycol, propylene glycol, p-xylene glycol, etc. at predetermined amounts and carrying out condensation reaction, particularly preferably polyethylene terephthalate (PET), etc.

(2) Sheath structure portion filament

As the resin (second component) which is used as the resin with a low melting point to be used for the outside sheath structure portion of the composition filaments of the abovementioned core-sheath structure, there may be employed thermoplastic resins having melting points lower by 15°C or more, preferably 30°C or more, such as low density polyethylene, high density polyethylene, ethylene-vinyl acetate copolymer, ethylene-propylene copolymer, low melting point polyester, polyamide resins such as nylon-6, etc. or mixtures of these.

Among the thermoplastic resins with low melting points to be used as the second component, polyesters with low melting points are preferable, particularly preferably copolymerized polyesters resins prepared by formulating aliphatic dicarboxylic acids such as adipic acid, sebacic acid, etc., aromatic dicarboxylic acids such as phthalic acid, isophthalic acid, naphthalene dicarboxylic acid, etc. and/or alicyclic dicarboxylic acids such as hexahydroterephthalic acid, etc. and aliphatic or alicyclic diols such as ethylene glycol, polyethylene glycol, propylene glycol, hexane diol, p-xylene glycol, etc. at predetermined amounts, adding, if necessary, an oxyacid such as p-xylene-benzoic acid, etc. and carrying out condensation reaction.

Specifically, there can be included copolymerized polyester resins prepared by formulating aliphatic dicarboxylic acids such as adipic acid, sebacic acid, etc., aromatic dicarboxylic acids such as phthalic acid, isophthalic acid, naphthalene dicarboxylic acid, etc. and/or alicyclic dicarboxylic acids such as hexahydroterephthalic acid, and aliphatic or alicyclic diols such as diethylene glycol, polyethylene glycol, propylene glycol, hexane diol, p-xylene glycol, etc. at predetermined amounts, adding, if necessary an oxyacid such as p-hydroxybenzoic acid, and carrying out condensation reaction.

Particularly, a polyester obtained by adding isophthalic acid and 1,6-hexane diol to terephthalic acid and ethylene glycol and carrying out copolymerization is preferable.

(3) Structure

These first component and second component are spun by the composite spinning method known in the art into the sheath-core type so that the first component may become the first component and the second component comprises 16 to 50%, preferably 25 to 40% of the whole cross-sectional area of the fibers.

By making the fiber cross-sectional area of the second component occupy the whole area at the ratio as mentioned above, the crossed points of warp threads and weft threads of the mesh fabric can be adhered through fusion of the second component by the heat treatment as described above.

For the composite filaments of the core-sheath structure as mentioned above, either one of mono-filaments and multi-filaments may be employed, and in the case of multi-filaments, the core components of the respective single filaments are agglomerated by the heat treatment as described below to be coated with the sheath component therearound, and worked as if they were like mono-filaments. However, when precise printing is to be conducted, it is preferable to use mono-filaments.

The fineness of the composite filaments with such core-sheath structure may be 1 denier or more, and one preferably of 5 to 200 denier, particularly preferably 20 to 100 denier, may be employed.

[II] Preparation of mesh fabric

(1) Fabrication

The mesh fabric may be prepared according to the same fabrication as conventional screen mesh fabric.

The fabricated density of the mesh fabric thus fabricated may be generally about 10 to 600/inch (100 to 600 mesh), preferably 50 to 350 mesh, but these fabricated densities may be suitably selected depending of the amount of ink fed during screen printing and the line width of the picture pattern, etc.

(2) Fusion

The mesh screen for screen printing of the present invention may be prepared by heating the mesh fabric fabricated as described above under the state applied with tension in both warp and weft directions to melt the sheath component of the core-sheath composite filaments constituting said mesh fabric and integrating said fabric, while applying a pressure, if necessary, followed by cooling.

(a) Tension

The tension during heating melting may be preferably 0.7 g or more, particularly 1 to 5 g per denier of the filament employed for both warp and weft threads. This value is stronger than the tension during ordinary gauze spanning, but should be limited to not higher than the yield point of the filament as a matter of course.

(b) Heating temperature

The heating temperature employed may be a temperature between the melting point of the sheath component of the core-sheath composite filament and the melting point of the core component, but preferably a high temperature near the melting point of the core component. Specifically, when the core component is a polyester fiber having an ordinary to high viscosity with an intrinsic viscosity (η) of about 0.6 to 1.2, and the sheath component is a polyester with low melting point, heating is effected to a temperature generally of 120 to 220°C, preferably 170 to 210°C.

[III] Mesh fabric

The mesh fabric (gauze) 1 thus obtained, as shown in Fig. 1, has the intersecting points 1a of the mesh fabric adhesion integrated by melting of the sheath component of the filaments constituting it, and therefore can be made a mesh fabric (gauze) free from mesh slippage. Although the mesh fabric 1 is adhered by melting, since the core threads in shape of filaments in both warp and weft, it has adequate elasticity and enables preparation of a screen printing plate excellent in printing adaptability.

Further, such mesh fabric 1 of the present invention can cancel substantially the flexion occurring by overlapping at the intersecting points of warp threads and weft threads inevitable in ordinary mesh fabric (while leading to lowering in printing precision by deformation of threads during printing) by melting the sheath portion of the core-sheath composite filaments under a tension applied on both warp and weft of said said mesh fabric, thereby adhering the intersecting points of warp threads and weft threads, to fix the fabric under the state applied on both warp and weft of the fabric, whereby a mesh fabric with very good precision can be obtained.

Therefore, the mesh fabric of the present invention, as shown in Fig. 2, can be made to have an appearance as if it were a mesh structure prepared by resin molding with the intersecting points of warp threads and weft threads being integrated on the surface with warp threads and weft threads, because the core fibers are mutually adhered at the intersecting points of warp threads and weft threads and the sheath components of warp threads and weft threads cover integrally over the surface.

Thus, since the mesh fabric of the present invention can be made a mesh fabric without flexion (smooth fabric with a thickness of 1.7-fold, preferably 1.6-fold or less of the diameter of the threads employed, but it is actually difficult to make the thickness, 1.2-fold or less ; for example, smooth fabric of 1.5-fold), no deformation of threads will occur during printing. It becomes possible to prepare a screen printing plate very excellent in printing precision.

The mesh fabric of the present invention becomes to have such appearance like a resin molded product, but since the fabric texture as a whole is covered uniformly with the melt of the sheath component of the core-sheath composite filaments constituting it, the openings of the mesh are maintained uniformly, whereby a screen printing plate with very good passability of ink can be made.

[IV] Preparation of photosensitive film (PS plate) for screen printing plate

Such mesh fabric (gauze) of the present invention can be also subjected to gauze spanning by securing on a screen frame under the state giving a tension similarly as ordinary mesh fabric (gauze) and then coating or laminating a photosensitive resin thereon to prepare a photosensitive resin for screen printing plate (PS plate). However, as described above, due to melting securance at the intersecting portions of both warp and weft threads, deformation or slippage of threads will occur with difficulty, and therefore, as shown in the sectional view of the photosensitive film for screen printing plate in Fig. 3, by laminating a photosensitive agent layer or a photosensitive layer 3 as such on the mesh fabric (gauze) 2 without mounting on the frame, a photosensitive film for screen printing plate (PS plate) 1 can be also prepared.

(1) Photosensitive layer

As the photosensitive layer 3 for forming the photosensitive film for screen printing plate (PS plate) laminated on the above-mentioned mesh fabric 2, known photosensitive agent, for example, those obtained by coating and drying of photosensitive emulsions of polyvinyl alcohol and a slight amount of vinyl acetate emulsion to which bichromates of photosensitive base and a slight amount of aids are added, or photosensitive films, for example, films obtained by coating and drying of a photosensitive emulsion constituted primarily of polyvinyl alcohol and a photosensitive base on plastic film bases, etc. can be also used.

These photosensitive agent layers or photosensitive film layers can be also formed on the back surface side after plastering a photosensitive film layer on the surface side of the above-mentioned mesh fabric.

Such photosensitive agent layer or photosensitive film layer is laminated with a thickness generally of 2 to 400 μm, preferably 5 to 20 μm.

(2) Lamination

For laminating the above-mentioned photosensitive agent layer of photosensitive film layer 3 without securance of the mesh fabric 2 of the present invention on a screen frame, various known lamination methods can be practiced such as the impregnation method and the lamination method as shown in Fig. 4 or fig. 5, or the water filling method, etc.

Specifically, for lamination according to the above-mentioned impregnation method, as shown in preparation of the photosensitive film for screen printing plate by the impregnation method in Fig. 4, the sheet-shaped mesh fabric 2 wound up in a roll is led into the bath tank 5 of the photosensitive emulsion 4 to be dipped therein, completely dried by heating in the dryer 6 at a temperature generally of 30 to 50°C, preferably 35 to 45°C, for 10 to 60 minutes, preferably 20 to 30 minutes, and the photosensitive agent layer 3a is laminated, followed by cutting into appropriate sizes, or winding up in a roll as the photosensitive film 7 for screen printing plate.

For lamination by the above-mentioned lamination method, as shown in preparation of the photosensitive film for screen printing plate by the lamination method in Fig. 5, the sheet-shaped mesh fabric 2 wound up in a roll is cut into appropriate sizes, or the mesh fabric 2 in a roll as such and the photosensitive film 3b wound up in a roll or cut into a sheet are superposed on each other, and this is adhered by sandwiching between a pair of pressurized heated rollers 8a, 8b to effect lamination. As the conditions of the pressurizing heating rollers, a pressure generally of 1 to 10 kg/cm^2, preferably 2 to 5 kg/cm^2, and yet a temperature generally of 50 to 120°C, preferably 70 to 100°C, may be maintained.

The photosensitive film for screen printing plate 7 thus laminated can be further cut by a cutter 9 to give sheet-shaped photosensitive films for screen printing plate 7.

If necessary, by laminating further an adhesive layer sandwiched between the above-mentioned mesh fabric and the photosensitive agent layer or the photosensitive film layer, peel-off of the photosensitive film layer can be further prevented.

The photosensitive film for screen printing plate (PS plate) thus obtained by laminating a photosensitive agent layer or photosensitive film layer as such without mounting on a frame is not gauze spanned on a screen frame, and therefore can be conveyed compactly by winding up or superposition, whereby conveying can be easily done without breaking of the photosensitive film for screen printing plate or relaxation of spanned mesh fabric during conveyance.

Further, durability of the plate is also high, and yet spanning can be done at the site of application, and therefore stretching and shrinkage of the plate film will occur with difficulty, whereby there are such advantages that a correct screen printing plate can be prepared, that good printing can be performed, etc.

(3) Printing

The photosensitive film for screen printing plate of the present invention as described above is obtained by use of a mesh fabric with the intersecting portions of both warp and weft threads secured by thermal fusion as the mesh fabric of the base, and laminating a photosensitive agent layer or photosensitive film layer thereon, and therefore the mesh intervals of said mesh fabric will be deformed with difficulty. Hence, when no precise screen printing is required, in setting on a screen printing machine, the photosensitive film for screen printing plate can be also gauze spanned on a screen frame simply by manual work without gauze spanning on a screen frame by use of the gauze spanning machine as described below.

However, when precise screen printing is required, it is desirable to perform gauze spanning of the photosensitive film for screen printing plate on a screen frame.

[V] Gauze spanning

In the case of preparing the photosensitive film for screen printing plate (PS plate) mounted on a frame as mentioned above, it is desirable to give a tension to the mesh fabric for screen printing of the present invention before lamination of the photosensitive agent layer or the photosensitive film layer.

(1) Screen frame

As the screen frame to be used for gauze spanning of the mesh fabric for screen printing of the present invention, there may be included generally those prepared from wood materials, metal material such as aluminum, stainless steel, steel iron, etc., but usually a square or rectangular frame prepared by working of an extruded material of aluminum may be employed from such points as strength, lightweight, corrosion, etc.

(2) Gauze spanning machine

For gauze spanning of the mesh fabric (gauze) for screen printing as mentioned above on the screen frame as described above, a gauze spanning machine conventionally used for gauze spanning of mesh fabric may be employed, specifically including air stretcher gauze spanning machine, large scale gauze spanning machine (motor driven long stand system).

(3) Gauze spanning method

(a) High tension maintenance

In carrying out gauze spanning of the above-mentioned mesh fabric (gauze) on the above-mentioned screen frame by use of the gauze spanning machine as described above, what is important is, as shown in the relationship between tension and time according to the operative method of the gauze spanning method of the mesh fabric for screen printing of the present invention in Fig. 6, to maintain the tension of the mesh fabric at a value higher by 10 to 100% than the value of tension during securance of said mesh fabric, preferably 10 to 50% when effecting gauze spanning at high tension (when employed for printing of print wiring board), 50 to 100% when effecting gauze spanning at low tension (when employed for printing such as textile printing), for 5 to 60 minutes, preferably 5 to 30 minutes.

By this operation, the core-sheath composite filaments thermally denatured in the preparation steps of the mesh fabric are returned again to the state where the fabric as a whole is stretched again, and therefore without leaving it to stand for a long time during gauze spanning, a mesh fabric subjected to gauze spanning under a constant force can be formed.

Accordingly, if the above-mentioned tension is lower than the range as defined above, the core material will not be stretched, whereby the change in tension during gauze spanning becomes greater.

On the other hand, if the above-mentioned tension is higher than the range as defined above, the core material will be broken to make gauze spanning of the mesh fabric impossible. Therefore, it is important to keep the tension within the range as defined above.

Further, if the above-mentioned maintenance time is shorter than the range as defined above, the core material cannot be sufficiently stretched to make the change in tension after fixing greater.

On the other hand, if the above-mentioned maintenance time is longer than the range as defined above, workability is lowered, and therefore it is important to keep the time within the range as defined above.

The tension by the above-mentioned gauze spanning machine can be measured by a tension gauge by Newton/cm representation or a tension gauge by mm representation.

(b) Tension release

After the mesh fabric (gauze) as described above is maintained under the above-mentioned tension, it is important to release once said tension.

By this operation, relaxation of the distortion during stretching of the core-sheath composite filaments can be effected. When no such release of tension is effected, there are involved the drawbacks that variance of tension may occur, or that distortion occurs in the screen, etc.

(c) Giving tension again

After the above-mentioned release of tension, the tension during securance is given again.

(d) Securance

While giving the above-mentioned tension, the mesh fabric is maintained for 5 to 60 minutes to secure it onto a screen frame.

Securance is generally done by coating of an adhesive.

As the adhesive, any material which can effect securance may be employed, but generally rubber type adhesives, etc. may be employed.

In the case of securing by coating of an adhesive, said adhesive is maintained under the state as such generally for about 5 to 60 minutes until it is solidified.

[VI] Screen printing plate

The screen printing plate obtained by gauze spanning a mesh fabric for screen printing prepared by thermally fusing composite filaments with the core-sheath structure using strong fibers as the inner core and covered at the outside portion with a resin of low melting point, laminating a photosensitive agent layer or a photosensitive film layer thereon and subjecting the laminate to exposure will not suffer from peel-off of the intersecting points of said mesh fabric, and can maintain the openings stably as such, whereby a screen of good precision can be prepared and yet ink passability therethrough is good. Moreover, at low mesh, it is not fluffy, free from mesh slippage, requiring no resin working. Further at high mesh, the intersecting points become non-intersecting points, without warping with lapse of time similarly as at low mesh, whereby marked improvements can be recognized in time shortening between the steps, workability. It also enables precise printing, whereby not only in screen printing in general, but also in printing for print wiring plate such as print circuit, multi-layer plate, IC circuit, etc., precise printing is rendered possible.

The screen printing plate gauze spanned by such gauze spanning method of the mesh fabric for screen printing of the present invention has the mesh fabric for screen printing as a whole under the state stretched, and therefore can be made a screen printing plate gauze spanned under a constant tension. Therefore, images are correct with distortion occurring with difficulty, and precise images can be drawn.

Experimental Examples

For further detailed description of the mesh fabric for screen printing, the process for preparing the same, the gauze spanning method of said mesh fabric onto a screen frame and the photosensitive film for screen printing plate having a photosensitive agent layer or a photosensitive film layer laminated on said mesh fabric on said mesh fabric, description is made specifically by referring to the following Examples and Comparative examples.

Example A1

Preparation of mesh fabric of core-sheath structure

With the use of core-sheath composite filaments comprising a polyethylene terephthalate having a melting point of 265°C as the core and a copolymerized polyester having a melting point 180°C (terephthalic acid/isophthalic acid = 75/25) as the sheath, mesh fabrics of 200 mesh, 250 mesh and 300 mesh were prepared, and the mesh fabrics were heated at 200°C under a tension of 1 g per denier applied in both warp and weft directions for 10 minutes to melt the copolymerized polyester of the sheath portion, thereby integrating the intersecting portions of warp and weft threads of the mesh fabrics, and thereafter left to cool.

Gauze spanning

The mesh fabrics for screen printing of the present invention thus obtained and a known mesh fabrics made of polyester which is commercially available for screen printing and can be gauze spanned at high tension (trade name : "Super Strong" manufactured by Nippon Tokushu Orimono) were each gauze spanned on a frame for screen printing made of aluminum by 3S air stretcher manufactured by Minogroup under the condition of a tension of 1.00 mm.

Preparation of photosensitive film for screen printing plate

Next, after the above-mentioned mesh fabric gauze spanned on a frame for screen printing was washed with an aqueous 0.2% neutral detergent solution and dried, a PVA-vinyl acetate type photosensitive emulsion NK-14 (manufactured by Hoechst, West Germany) was coated and dried, followed by overlaid coating to prepare a photosensitive film for screen printing plate with a thickness of 10 to 12 μm.

Measurement of printing precision

Next, on the photosensitive film for screen printing plate by use of such each mesh fabric, the following two kinds of test patterns were printed.

(I) A lattice pattern with fine lines crossed at longitudinal and lateral intervals of 150 mm.

(II) A pattern with fine lines of thicknesses of 50 μm, 60 μm, 80 μm, 100 μm, 125 μm, 150 μm, 200 μm, 250 μm, 300 μm juxtaposed each in five lines at equal intervals.

Printing of the above-mentioned test pattern was carried out by use of a metal halide lamp of 3 KW and exposure was effected at a distance of 80 cm for 3 minutes.

Next, after dipping in water for 30 minutes, the unexposed portion was removed by water spray.

For the mesh fabrics subjected thus to printing of the patterns of (I) and (II), the printing slippage test, the reproducibility test of fine lines when performing printing with the pattern of (I) for 1,000 times (sheets), 3,000 times (sheets) were practiced for measurement of printing precision. Particularly, printing slippage was examined with the pattern of (I), and the reproducibility was measured with the pattern of (II). The printing conditions at this time are as shown below.

Plate preparation conditions

Gauge spanning machine :	3S air stretcher manufactured by Minogroup
Aluminum frame :	commercial product 880 mm x 880 mm square
Tension :	1.00 mm
Emulsion film thickness :	12 μm
Image :	300 mm x 300 mm

Squeezee conditions

Kind :	urethane
Hardness :	70°
Angle :	75°
Width :	405 mm

Printing condfitions

Gap :	3.0 mm
Printing pressure :	1.5 mm
Ink viscosity :	200 PS

The above results are shown in Table A1 and Table A2.

Table A1 (Fine printing resolution evaluation)

Mesh fabric	Resolving power	Fabric thickness
Product of Invention		
200 mesh	80 μm	1.7-fold or less of filament diameter
250 mesh	60 μm	"
300 mesh	50 μm	"
Polyester heat-treated product		
200 mesh	150 μm	2.0 to 2.2-fold of filament diameter
250 mesh	150 μm	"
300 mesh	125 μm	"

Table A2 (Pattern of printing precision evaluation (I))

		Polyester 200 mesh				Product of Invention (200 mesh)	
		Treated at 200°C		Untreated			
No.	Printing times	1,000	3,000	1,000	3,000	1,000	3,000
1		95	138	228	352	19	35
2		101	140	238	358	23	54
3		120	164	180	379	38	61
4		92	120	236	327	26	37
5		108	142	193	458	46	65
6		106	159	197	421	50	58
7		100	126	223	427	26	47
8		114	161	256	383	36	50

		Polyester 250 mesh				Product of Invention (250 mesh)	
		Treated at 200°C		Untreated			
No.	Printing times	1,000	3,000	1,000	3,000	1,000	3,000
1		108	146	194	238	23	34
2		106	165	200	248	42	57
3		124	169	219	264	35	54
4		98	121	208	221	31	50
5		107	168	207	243	54	66
6		96	155	199	279	37	65
7		100	170	214	226	16	31
8		124	172	205	261	38	53

Table A2 (continued)

		Polyester 300 mesh				Product of Invention (300 mesh)	
		Treated at 200°C		Untreated			
No.	Printing times	1,000	3,000	1,000	3,000	1,000	3,000
1		115	148	225	348	15	30
2		108	170	218	370	33	59
3		127	193	257	374	50	61
4		97	130	284	394	28	40
5		104	172	204	372	35	60
6		99	168	199	384	46	62
7		101	141	202	348	16	44
8		130	165	230	375	26	53

Example B1

Preparation of mesh fabric of core-sheath structure

By using a polyethylene terephthalate (PET) with a melting point of 265°C as the core layer and a low melting polyester with a melting point of 200°C as the sheath layer, respectively, and performing stretching of the layers, composite mono-filaments of 23 denier, strength of 5.0 g/d and elongation of 30% were obtained.

The composite monofilaments were made up to a fabric with a count of 150/inch x 150/inch, and the intersecting portions of both warp and weft threads were thermally fused in a heating machine at a temperature of 205°C while applying a tension of 1 g per denier in both warp and weft directions to obtain a mesh fabric for screen printing of 150 mesh.

Gauze spanning

The mesh fabric for screen printing thus obtained was set by a tension gauze to 1.0 mm so that the initial tension became 28 Newton/cm (17% higher than the target value), as shown in the gauze spanning method of the mesh fabric for screen printing of the present invention in Fig. 6 by use of an air stretcher gauze spanning machine (manufactures by Murakami Screen K.K.), and maintained for 10 minutes, followed by release of said tension.

A tension was again given, and after maintaining the tension set by a tension gauge to 1.2 mm so that the tension became 24 Newton/cm for 10 minutes, the fabric was adhered onto an aluminum frame (dimensions : frame width 40 mm x thickness 30 mm x outer dimension 950 mm square) with a rubber type adhesive. Under the state held as such for 60 minutes, gauze spanning was effected while giving tension until the adhesive was solidified.

The tension of the screen plate was found to be initially 24 Newton/cm (target value).

The tension of the screen plate when maintained for 7 days was lowered with lapse of time as show in Table B1.

Preparation of photosensitive film for screen printing plate

The screen plate prepared as described above was coated with a photosensitive film (MS-50FILM manufactured by Murakami Screen K.K., 25 μm thickness) on the print surface side by means of a photosensitive film plastering machine (MS-film applier manufactured by Murakami Screen K.K.) and also a plastering emulsion (OP-50M manufactured by Murakami Screen K.K., containing a diazo compound) on the squeezee surface side, thereby forming a resin photosensitive film to a thickness of 10 μm.

This was dried at a temperature within 40°C, and a posi (lattice pattern) for printing was printed by 4 KW ultra-high pressure mercury lamp (distance 1 m) for adequate exposure time of 30 to 40 seconds, followed by developing, drying, back exposure, and the film hardening treatment was applied with zirconium nitrate.

Measurement of printing precision

Next, after measurement of 9 points (intersecting portions of the lattice pattern) of the posi and the plate by use of a length measuring machine, printing was performed by an automatic printing machine under the printing conditions set as shown below for 1,000 times, 2,000 times, 3,0000 times, and again the positions of the above-mentioned 9 points of posi and plate were measured. Printing precision was determined by comparison between the plate before printing and the printed product.

The results are shown in Table 2.

Printing conditions

Automatic printing machine used :	Supermec automatic printing machine manufactured by Sias
Squeezee angle :	70°
Squeezee hardness :	80°
Squeezee width :	400 mm
Squeezee speed :	250 mm/sec.
Drop amount :	0.66 mm
Gap :	3 mm
Ink used :	Heat drying type etching resist, X-87, manufactured by Taiyo Ink Seizo K.K.
Transfer medium :	PET film (188 μm thickness x 500 mm x 500 mm)
Length measuring machine :	Model DR-550-F manufactured by Dainippon Screen Seizo K.K. was employed.

Example B2

Example B1 was repeated except that the tension gauge was set to 2.0 mm so that the initial tension became 12.9 Newton/cm (70% higher than the target value), and setting the tension gauge to 3.0 mm so that the tension after release became 7.6 Newton/cm (target value).

The results are shown in Table B1.

Comparative example B1 (direct drawing method)

The mesh for screen printing of 150 mesh comprising the mesh fabric of the core-sheath structure used in Example B1 thermally fused was set by a tension gauge to 1.2 mm so that the initial tension became 24 Newton/cm as shown by the direct drawing method in Fig. 7 by means of an air stretcher gauze spanning machine and maintained for 2 to 3 minutes, followed by adhesion onto an aluminum frame (dimensions : frame width 40 mm x thickness 30 mm x outer dimensions 950 mm square) with a rubber type adhesive. After maintained under the state as such for 60 minutes, gauze spanning was effected while giving a tension until the adhesive was solidified.

The tension of the screen plate obtained was found to be initially 24 Newton/cm, but lowering of the tension with lapse of time when the screen plate was maintained for 7 days was as shown in Table B1.

Printing precision was measured also similarly as in Example B1.

The results are shown in Table B2.

Comparative example B2 (stepwise draw-up method)

The mesh for screen printing of 150 mesh comprising the mesh fabric of the core-sheath structure used in Example B1 thermally fused was set by a tension gauge to 2.3 mm so that the initial tension became 10.5 Newton/cm (44% of the target value) as shown by the stepwise draw-up method in Fig. 8 by means of an air stretcher gauze spanning machine, then the tension was increased at 0.2 mm per 1 minute for 5 minutes so that the tension became 22 Newton/cm (92% of the target value) and maintained by a tension gauge at 1.3 mm for 10 minutes, followed again by increase of the tension to 1.2 mm by a tension gauge so that the tension became 24 Newton/cm, which was maintained for 15 minutes, and the fabric was then adhered onto an aluminum frame (dimensions : frame width 40 mm x thickness 30 mm x outer dimensions 950 mm square) with a rubber type adhesive.

After maintained under the state as such while giving tension for 60 minutes, the fabric was dried until the adhesive was solidified at room temperature, and then said tension was released.

The tension of the screen plate obtained was found to be the initial 24 Newton/cm (target value).

Lowering of the tension with lapse of time when the screen plate was maintained for 7 days was as shown in Table B1.

Table B1

	Initial tension (mm)	Day 1	Day 2	Day 3	Day 4	Day 5	Day 6	Day 7
Example B1	1.20	1.20	1.20	1.20	1.20	1.20	1.20	1.20
Example B2	3.00	3.00	3.00	3.00	3.00	3.00	3.00	3.00
Comparative example B1	1.20	1.38	1.45	1.47	1.48	1.49	1.49	1.49
Comparative example B2	1.20	1.31	1.36	1.38	1.39	1.39	1.39	1.39

Table B2

	Printing times	Maximum elongation		Minimum elongation		Average value	
		X	Y	X	Y	X	Y
Example B1	1,000	51	165	1	21	22	74
	2,000	48	179	0	22	26	81
	3,000	59	188	4	25	30	85
Comparative example B1	1,000	76	250	1	42	36	121
	2,000	90	252	3	51	43	124
	3,000	116	262	7	55	57	129

(Unit: μm)

Example C1

Preparation of mesh fabric of core-sheath structure

By using a polyethylene terephthalate (PET) with a melting point of 265°C as the core layer and a low melting polyester with a melting point of 200°C as the sheath layer, respectively, and performing stretching of the layers, composite monofilaments of 23 denier, strength of 5.0 g/d and elongation of 30% were obtained.

The composite monofilaments were made up to a fabric with a count of 150/inch x 150/inch, and the intersecting portions of both warp and weft threads were thermally fused in a heating machine at a temperature of 205°C while applying a tension of 1 g per denier in both warp and weft directions to obtain a rolled product of a mesh fabric for screen printing of 150 mesh.

Preparation of photosensitive film for screen printing plate

First, an expanded styrol was placed on a flat plane, and a photosensitive film (MS-50FILM manufactured by Murakami Screen K.K., 25 μm thickness) was placed thereon with the emulsion surface upside. On this composite was placed the mesh fabric for screen printing obtained as described above, and a mixture of water and isopropyl alcohol (mixing ratio 4 : 1) was sprayed by a spray, and after left to stand for about 10 seconds, a squeezee was moved thereon once in reciprocal fashion with the mesh fabric for screen printing being pressed with a hand. Superfluous water was wiped off with chamois skin, followed by drying in a hot air dryer of about 40°C for 20 minutes, to give a photosensitive film for screen printing having a photosensitive agent layer with a thickness of 3 μm laminated thereon.

Preparation of screen plate

Next, a screen plate was prepared by spanning the photosensitive film for screen printing plate on a screen frame by manual work. The tension of the screen plate at this time was found to be 5.6 Newton/cm.

Measurement of printing precision

The screen plate prepared as described above was printed by use of a posi (lattice pattern) for printing test with a 4 KW ultra-high pressure mercury lamp (distance 1 m) for an adequate exposure time of 30 seconds, followed by developing, drying, back exposure, and the film hardening treatment was applied with zirconium nitrate.

Next, after measurement of 9 points (intersecting portions of the lattice pattern) of the posi and the plate by use of a length measuring machine, printing was performed by an automatic printing machine under the printing conditions set as shown below for 1,000 times, 2,000 times, 3,0000 times, and again the positions of the above-mentioned 9 points of posi and plate were measured. Printing precision was determined by comparison between the plate before printing and the printed product.

The results are shown in Table C1.

Printing conditions

Automatic printing machine used :	Supermec automatic printing machine manufactured by Sias
Squeezee angle :	70°
Squeezee hardness :	80°
Squeezee width :	400 mm
Squeezee speed :	250 mm/sec.
Drop amount :	0.66 mm
Gap :	3 mm
Ink used :	Heat drying type etching resist, manufactured by Taiyo Ink Seizo K.K.
Transfer medium :	PET film (188 μm thickness x 500 mm x 500 mm)
Length measuring machine :	Model DR-550-F manufactured by Dainippon Screen Seizo K.K. was employed.

Example C2

Preparation of photosensitive film for screen printing plate

In preparation of the mesh fabric of the core-sheath structure of Example C1, the mesh fabric for screen printing 2 in shape of a rolled product prepared was dipped by leading into the bath 5 of the photosensitive emulsion 4 by use of the lamination device shown in Fig. 4, and then completely dried by heating at a temperature of 45°C for 30 minutes in the dryer 6, to obtain a photosensitive film for screen printing plate 7 having the photosensitive agent layer 3a with a thickness of 30 μm laminated thereon.

Example C3

Preparation of photosensitive film for screen printing plate

In preparation of the mesh fabric of the core-sheath structure of Example C1, the mesh fabric for screen printing 2 in shape of a rolled product prepared and the photosensitive film 3b cut into an appropriate size were superposed on one another by use of the lamination device shown in Fig. 5, which were sandwiched between a pair of pressurizing heating rollers 8a, 8b maintained under a pressure of 3 kg/cm^2 and a temperature of 90°C to effect lamination, and the laminated product was further cut by the cutter 9 to obtain a photosensitive film for screen printing plate 7 having the photosensitive film 3b of 5 μm laminated thereon.

Comparative example C1

Preparation of screen plate

A commercially available mesh fabric made of a polyester (Super Strong 150 mesh, manufactured by Nippon Tokushu Orimono) was spanned onto a screen frame by means of an air stretcher gauze spanning machine (manufactured by Murakami Screen K.K.) to the initial tension of 5.6 Newton/cm.

Next, the photosensitive film was plastered similarly as described in Example C1 to prepare a screen plate having a photosensitive agent layer with a thickness of 2 μm laminated thereon.

Measurement of printing precision

Printing precision was measured similarly as in Example C1.
The results are shown in Table C1.

Table C1

	Printing times	Maximum elongation		Minimum elongation		Average value	
		X	Y	X	Y	X	Y
Example C1	1,000	78	177	4	32	36	82
	2,000	82	192	7	35	40	87
	3,000	89	200	9	39	45	91
Comparative example C1	1,000	109	242	5	44	62	126
	2,000	114	270	10	61	66	138
	3,000	134	281	13	69	75	155

(Unit: μm)

Claims

1. A mesh fabric for screen printing, which is a mesh fabric obtained by use of core-sheath composite filaments in which a component with lower melting point than the core is employed, characterized in that warp and weft threads are adhered to each other at the intersecting points of warp and weft threads by melting of the sheath component after fabrication to cover its surface integrally with the sheath components of the warp and weft threads, whereby the intersecting points of warp and weft threads are integrated on the surface with the warp and weft threads.

2. A mesh fabric for screen printing, which is a mesh fabric obtained by use of core-sheath composite filaments in which a component with lower melting point than the core is employed, characterized in that warp and weft core threads are adhered to each other at the intersecting points of warp and weft threads by melting of the sheath component after fabrication to cover its surface integrally with the sheath components of the warp and weft threads, whereby the intersecting points of warp and weft threads are integrated on the surface with the warp and weft threads.

3. A mesh fabric for screen printing according to claim 1 or 2, wherein the core structure portion on the innerside of the core-sheath composite filament is a polyester fiber, and the sheath structure portion on the outside is constituted of a thermoplastic resin having a melting point lower by 15°C or more than the

thermoplastic resin of the core structure portion.

4. A mesh fabric for screen printing according to any one of claims 1 to 3, wherein the sheath structure portion on the outside of the core-sheath composite filament comprises 16 to 50% of the whole fiber cross-sectional area.

5. A mesh fabric for screen printing according to any one of claims 1 to 4, wherein the fineness of the composition filament with the core-sheath structure of the mesh fabric is 5 to 200 denier,

6. A mesh fabric for screen printing according to any one of claims 1 to 5, wherein the fabrication density of the fabric is 10 to 600 mesh.

7. A process for preparing a mesh fabric for screen printing, which comprises heating a mesh fabric obtained by fabrication of core-sheath composite filaments by use of a component for the sheath with a lower melting point than the core under the state with a tension of 0,7 g or more per denier applied in both warp and weft directions, thereby melting the sheath component of the core-sheath composite filaments to integrate it on the surface, followed by cooling.

8. A process for preparing a mesh fabric for screen printing according to claim 7, wherein an ordinary or high viscosity polyester fiber with an intrinsic viscosity (η) of about 0.6 to 1.2 is used for the core component of the core-sheath composite filaments, a polyester with a lower melting point is used for the sheath component and heating is carried out at a temperature of 120 to 220°C.

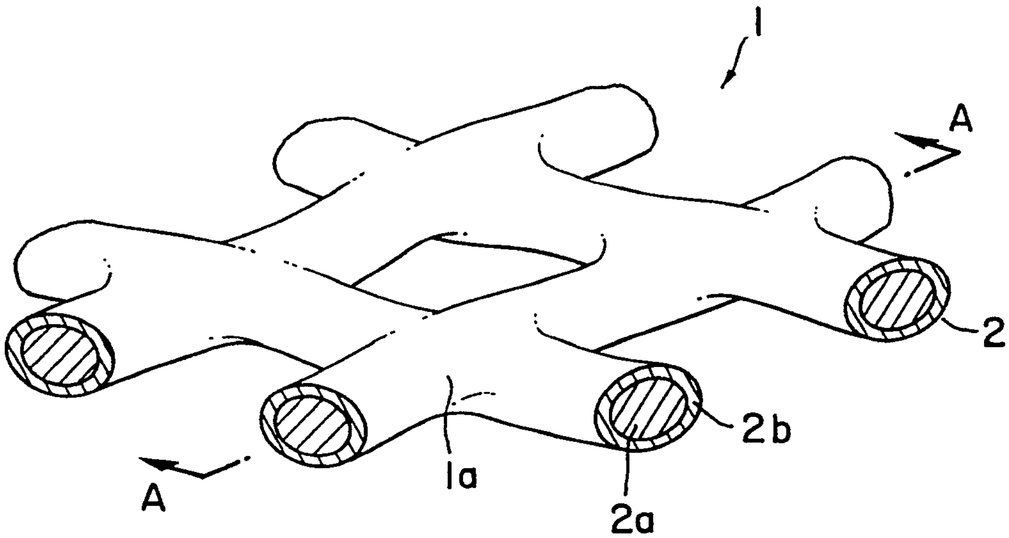
9. A method for gauze spanning of a mesh fabric for screen printing by securing a mesh fabric for screen printing having intersecting portions of both warp and weft threads secured by thermal fusion under the state with a tension given onto a screen frame, which comprises maintaining the tension of said mesh fabric at a value higher by 10 to 100% than the value of the tension during securing of said mesh fabric for 5 to 60 minutes, then releasing once said tension, and thereafter giving again a tension and maintaining it to the tension at the time of securing of said mesh fabric for 5 to 60 minutes, followed by securing of said mesh fabric onto the screen frame.

10. A photosensitive film for screen printing, comprising a photosensitive agent layer or a photosensitive film layer laminated on a mesh fabric having the intersecting portions of both warp and weft threads secured by thermal fusion thereon.

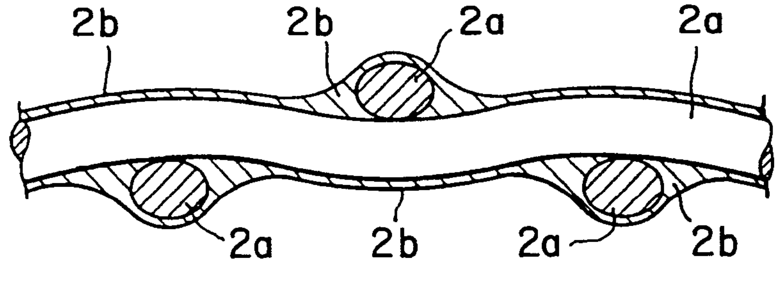
11. A photosensitive film for screen printing according to claim 10, wherein the photosensitive agent layer or the photosensitive film layer is laminated with a thickness of 2 to 400 μm.

12. A photosensitive film for screen printing according to claim 10 or 11, wherein a sheet-shaped mesh fabric wound up in a roll is dipped in a photosensitive emulsion, dried and wound up.

13. A photosensitive film for screen printing according to claim 10 or 11, wherein a sheet-shaped mesh fabric wound up in a roll is superposed on a photosensitive film in shape of a roll, and laminated by pressurizing heating rollers.



F I G. 1



F I G. 2

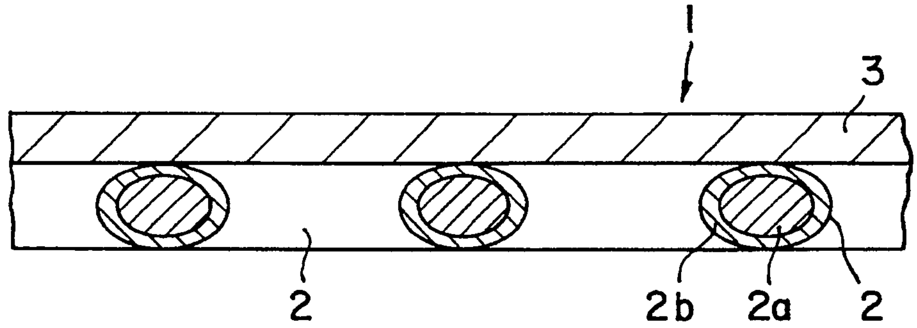


FIG. 3

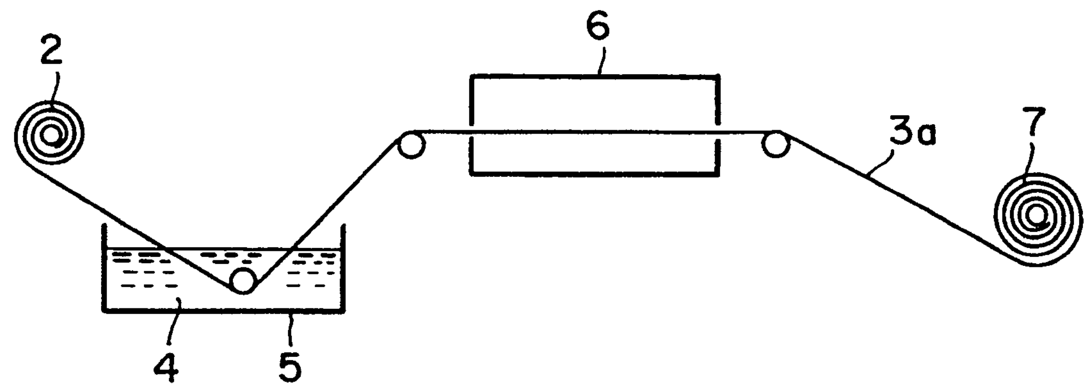


FIG. 4

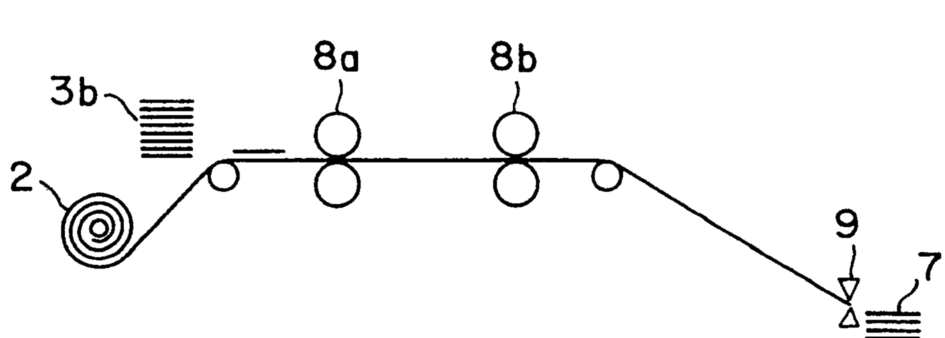


FIG. 5

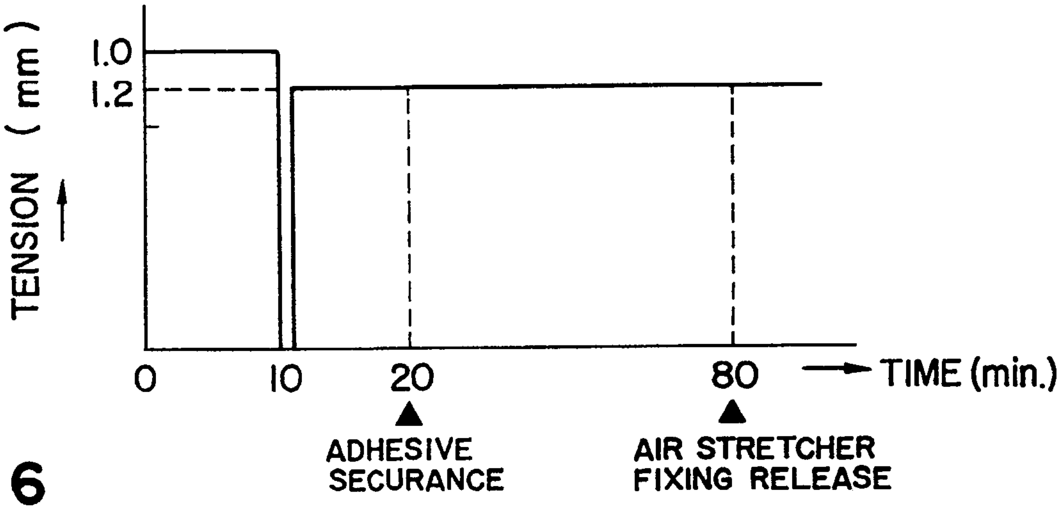


FIG. 6

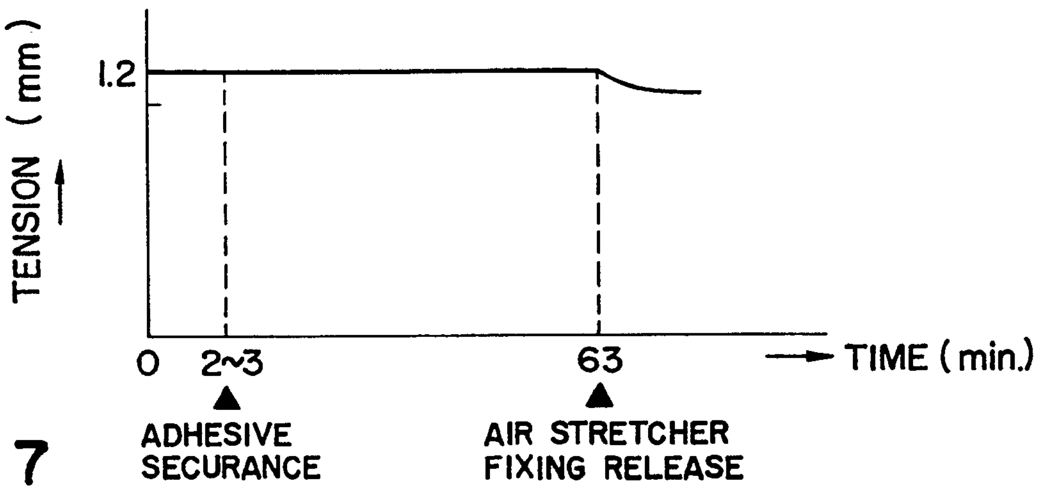


FIG. 7

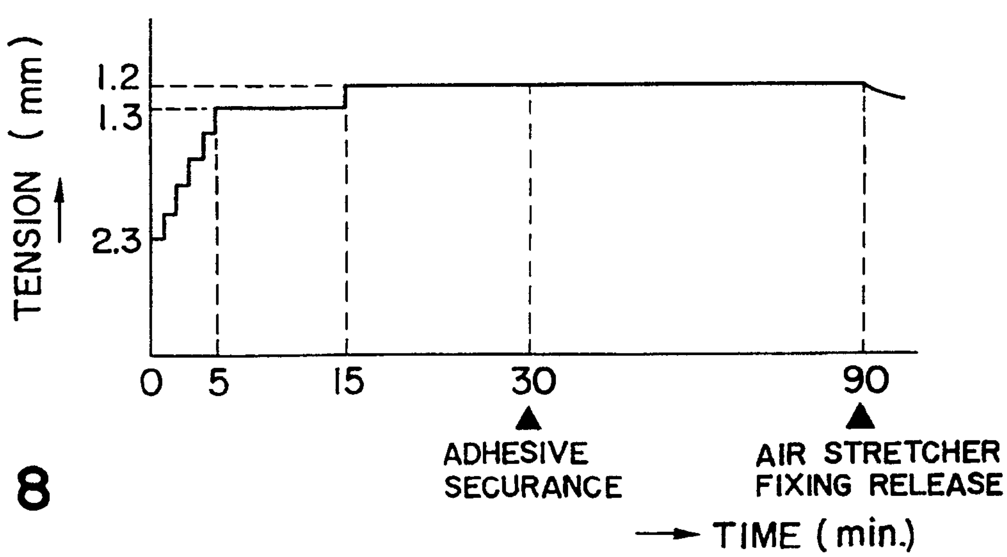


FIG. 8