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⑤④ **Process for the manufacture of network packages and network packages manufactured by this process.**

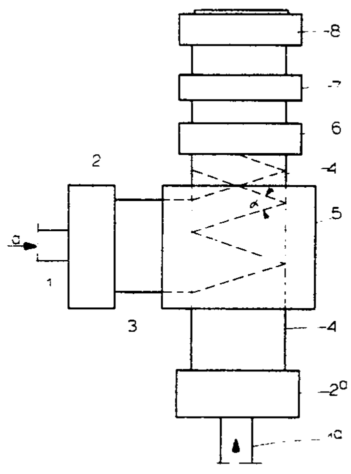
⑤⑦ The invention relates to a process for the manufacture of network packages from reticulate webs obtained by stretching, fibrillating and spreading of a film of organic polymeric material. Network packages according the invention are obtained in that:

a. one or more reticulate webs (3), one on top of the other, are continuously supplied and laid onto a carrier (4);
b. the reticulate webs are folded zig-zag on this carrier (4);
c. the folded network is continuously transported in a direction virtually normal to the direction in which the reticulate webs are supplied;
d. further, at one or both sides of the resultant folded network, reticulate webs are applied, which webs are stretched longitudinally and in the direction of transport, fibrillated and spread, and are supplied in the direction of transport of the folded network and joined with it;
e. the resultant combination of reticulate webs is carried off;

the rate of supply of the reticulate webs to be folded and the rate of discharge of the folded reticulate webs being chosen so that the angle between two successive folded sides of reticulate webs is between 1 and 50°C and in particular between 1° and 20°.

By preference only at one of the two sides of the resultant folded network package, reticulate webs streched in the transport direction are applied, and at the other side only one or two of such webs.

The resultant folded network packages are integrated into a whole by welds at the sides and are passed between heated rollers (7).



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TITLE MODIFIED

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PROCESS FOR THE MANUFACTURE OF NETWORK PACKAGES

The invention relates to a process for the manufacture of network packages from reticulate webs obtained through stretching, fibrillating and spreading of film of organic polymer material.

Such network packages can be used for reinforcement of brittle materials, such as brittle plastics; for reinforcement of water-hardening materials, such as cement and gypsum; as insulation material; as carpet underlay; as filler material in the clothing industry, and also as reinforcement material in road building construction and in water-defense work, such as dikes.

The Netherlands Patent Application No. 7714571 describes a process for the application of networks as reinforcement in water-hardening material. The product obtained showed considerable deviations in strength in different directions. For elimination of this drawback it was proposed, inter alia, to apply several networks disposed angularly relative to each other or to apply several networks which have been stretched, fibrillated and spread at different angles. Further it has been proposed to use instead of several networks at the same time one network folded zig-zag. This proposal is said to require complicated equipment and to yield products with inferior strength properties. The inferior strenghth properties of the products obtained is due to the zig-zag folding in the transport direction of the networks, the continuously fed network being folded onto itself in the transport direction as a result of a reciprocating motion. The number of layers is indeed increased, but these show considerable discontinuities, so that the fibres of the networks cannot sufficiently transmit stresses because they do not run continuously.

Fibre packets can be manufactured starting from discontiuous, chopped fibres of filaments, which webs are made coherent through carding and needling. However, such webs have a low tensile strength and the cost of manufacture is high.

Another possibility is to start from webs of spun or extruded thermoplastic filaments or fibrils, but these webs also have a low tensile strenght owing to the low tensile strength of the only little stretched filaments or fibrils and to the low strength of the inter-fibre bonding. If these fibre packets are used in a matrix material like cement, plastics, resins or if they are bonded together by means of adhesives or welds, the tensile strength of the resultant product would be unsatisfactory.

It also appears that it is very difficult to achieve a completely homogeneous random distribution. In order yet to achieve sufficient strength in all directions, larger layer thicknesses are therefore used. Nevertheless irregular strength distribution remains in the fribrous films and the packages manufactured therefrom.

The object of the present invention is to provide a process for the manufacture of network packages from networks obtained through stretching, fibrillating and spreading of a film of organic polymeric material, which process does not have the said drawbacks and with which an even distribution of the fibres over a given surface area is achieved, so that less material is needed.

According to the invention this is achieved in that:

a. one or more reticulate webs, one on top of the other, are continuously supplied and laid onto a carrier;

b. the webs are folded zig-zag on this carrier;

c. the folded network is continuously transported in a direction virtually normal to the direction in which the reticulate webs are supplied;

d. further, at one or both sides of the resultant folded network, reticulate webs are applied, which webs are stretched longitudinally and in the direction of transport, fibrillated and spread, and are supplied in the direction of transport of the folded network and joined with it;

e. the resultant combination of reticulate webs is carried off;

the rate of supply of the reticulate webs to be folded and te rate of discharge of the folded reticulate webs being chosen so that the angle between two successive folded sides of the reticulate webs is between 1° and 50°. This angle is called the overlap angle.

In the present invention, the uniform high strength in the longitudinal direction of the networks can be converted into strength in any desired direction or even into uniform strength in all directions due to the special manner of folding.

Networks made from stretched and fibrillated film have very high tensile strengths in the stretching direction. When the network packages made from these networks in accordance with the present invention are used in cement, plastics or resins or when the networks are bonded together by means of adhesives or welds, the resultant tensile strength is high due to the high tensile strength of the coherent filaments and/or fibrils. The transversal strength, however, is very low. The simply transverse folding gives a network package with high irregularities, which makes processing difficult. The invention thus provides a process to distribute this high tensile strength homogeneously over the two-dimensional plane, if desired in a matrix material.

A network of fibrillated plastic film is preferably prepared by extruding a plastic to form a film with a thickness of between 10 and 1000 µm, in particular between 50 and 500 µm, which film may be cut into strips, stretching it to for instance 10 times the original size, resulting in a thickness of preferably between 5 and 150 µm, which brings the materal into a state of imminent fibrillation, and next passing it over a pin roll, brush or comb or subjecting it to shearing forces by means of rollers or air streams. The fibrillation may also be effected by twisting. Subsequently, the stretched and fibrillated film is spread to form a network. A continuous web of such a network may consist of a coil of this material, but also of a direct supply from an extruder, the extruded film being stretched and fibrillated between the extruder mouth and the place where the networks are folded.

The term 'continuous' also refers to the use of a certain length of such a reticulate web, fed for instance from a coil, which length is many times larger however than the size of the product ultimately formed. The reticulate web applied according to the invention therefore consists of continous fibres. This means that the elements of which the network is made up, such as fibres and fibrils, extent virtually throughout the network package.

By 'spreading of the stretched and fibrillated film' is meant enlargement of the dimensions in a direction which is virtually normal to the stretching direction. Preferably, the widening is by a factor of at least 4, for instance 6 to 12. If tubular film is used, this can be done by draiwing the fibrillated film over a conical mandril, as described in the

non-prepublished British patent applicatio No. 41478, dated 21st Oct. '78. Another method, which is also applicable for flat film and for a pack of films, one on top of the other consists in lateral spreading by means of clamping rollers, and has been described in the non-preblushised Netherlands Patent Application No. 7905782. In the spreading process, the longitudinal or transverse dimension is enlarged.
The fibrillated film is thus made into a network with meshes formed by coherent fibrils and filaments.
The reticulate webs are preferably dimensionally stabilized after the enlargement, for instance by heating and/or spraying with a resin-like material. This spraying gives the additonal advantage of preventing the reticulate webs superimposed one upon te other from being displaced relatively to each other during processing in an installation for manufacture of reinforced products.

The carrier onto which the reticulate webs are laid and on which they are folded may be a driven conveyor belt, but also for instance a table with one or more detached driven rollers for continous discharge of the folded network package.

The rate of supply of the reticulate webs and the rate of discharge of the folded reticulate webs are preferably chosen so that the angle between to successive folded sides of the reticulate webs is between 1 and 50°,in particular between 1° and 20°.
It is required for one or more additional reticulate webs, stretched longitudinally or in the transport direction, to be supplied in the direction of motion of the folded network package.

The overlap angle can be adjusted by varying the ratio of the rate of supply of the web fed in to the rate of discharge of the folded networks. However there may be a great difference in width between the supplied and the discarged reticulate webs, which is an additional factor determining the overlap angles. This means that with the maximum practicable overlap angles will also be workable in practice. This means that with the maximum practicable overlap angle, the tangent of half the angle is equal to half the ratio between the widths of the supplied and the discharged reticulate webs.

A network package is preferably made up as follows: at one of the two sides of the folded network, reticulate webs stretched in the transport direction are applied and at the other side only one or two of such reticulate webs, after which the whole is combined.

The folding can be simplified by directing small air flows internally at the folding lines, in such a manner that these folding lines are pushed in a direction opposite to the folded reticulate webs. This causes the pressure forces on the reticulate webs along the folding lines during the folding to be converted into tensile forces, so that irregularities along the folding lines such as wrinkles, are prevented.

The resultant network packages, are integrated into a whole preferably by welding the edges together, for instance by ultrasonic or thermal methods, which facilitates handling and later application. For better handling the webs of the package may also be welded together at other places, for instance in the middle. It is advantageous to compact the network package obtained, for instance by passing it between rollers; the network package is thereby also levelled. One or more of the rollers may be treated, for instance to 75-125°C.

The network packages manufactured according to the invention show better properties, in particular with regard to the strength properties in the different directions, due to the special manner of zig-zag folding. Moreover, the required equipment is relatively uncomplicated. There are few irregularities and the network packages is well-processable.

The choice of the type of network used depends on the demands inherent in the application.

The plastic used for the preparation of the fibrillated films may be a polyolefine, but also other film-forming and fibre-forming thermoplastics are suitable, such as polymers of styrene, acrylonitrile or vinyl chloride and copolymers thereof. In particular, partially crystalline polymers are used, such as polyamides and modified polyesters.Special preference is given to polyolefines, modified or non-modified. Most preference is given to ethylene or propylene homopolymers, although copolymers and block copolymers may also be used. As a matter of course, mixtures of polymers may also be used.

To the polymers all kind of filler and auxiliary materials may be added, such as carbon black, polar compounds, pigments, light and heat stabilization agents and anti-oxidation agents. It is of great importance that the correct stabilization agents be added to the networks.

Favourable results may be achieved with a combination of a metal de-activator and an anti-oxidant. These compounds are used in quantities of 0.001 to 2.5 % by wt., in particular 0.01 to 1 % by wt.

The invention will now be elucidated with reference to a drawing, in which:

Fig. 1 is a diagrammatic top view of the device for the folding of reticulate webs into network packages, and

Fig. 2 is an elevation of the folding device from Fig. 1 for the reticulate webs, viewed normal to the direction of transport of the folded network.

As appears from Fig. 1, one layer or several layers, one upon the other, of non-spread, stretched and fibrillated film is supplied, in the direction indicated by arrow a, to a spreading and stabilization unit 2. After spreading of the network and subsequent stabilization at the resultant width, this network 3 is supplied to a folding unit 5 arranged over carrier 4.

The direction of supply of the network 3 is normal to the carrier 4. This carrier 4 may be a belt conveyor or a table provided at the discharge end with driven rollers which continuously discharge the folded network.

Unit 5 deposits the reticulate webs 3 onto carrier 4 and folds them on it, with a continuous reciprocating motion at right angles to carrier 4. As the network is continuously discharged, it is folded to a zig-zag, the degree of this zig-zagging being dependent upon the rate at which the reticulate webs are supplied to the folding device and the rate of which the folded network is discharged on carrier 4. In other words, the overlap angle α, i.e. the angle between two successive folded sides of the reticulate web, is determined by these factors. One or more further reticulate webs may be added to the folded network, applied longitudinally in relation to the folded network. As the drawing shows, an additional supply unit for non-spread, stretched and fibrillated film 1a is arranged ahead of the supply end of carrier 4.

This film is spread to the desired width and stabilized at this width in spreading and stabilization unit 2a, to be subsequently supplied longitudinally in relation to carrier 4, so as to be integrated with the folded network obtained.These additional reticulate webs may be applied to one or to both sides on the folded network package. The obtained folded network package, with or without additional reticulate webs, is welded at the sides by means of a welding unit 6. Welding may be by an ultrasonic or by a thermal method. To further facilitate handling, welding unit 6 may additionally weld the package in the middle. After welding unit 6 heated rollers 7 are installed between which the network package is passed for compacting and levelling it. The network package leaving rollers 7 can be coiled onto a reel 8.

Fig. 2 shows an elevation of the folding unit 5 of Fig. 1, as viewed in the direction normal to that in which the folded network is discharged. The network 3 -consisting of one or of several webs - leaving the spreading and stabilization unit 2, is supplied by a transport unit 10 in a direction normal to that in which the folded network is discharged. At the end 11 of transport unit 10 network 3 is passed on, with the aid of a guide 12, to a transport unit 13 reciprocating in a direction normal to carrier 4, and at the end 14 of this unit 13 it is passed on to a transport unit 15, likewise reciprocating in a direction normal to carrier 4, which unit 15 takes the network to its end 16. At the end 16 there is a guide roller 17 which deposits the network 3 onto carrier 4. This roller 17 likewise reciprocates, synchronously with transport unit 15. Owing to the reciproating motion of transport unit 15 and guide roller 17 in a direction normal to carrier 4, network 3 is deposited onto carrier 4 in the folded condition. As this carrier may be, for instance, a continuously running belt conveyor, network 3 is folded zig-zag onto carrier 4. As remarked before, the overlap angle α between two successive sides of the folded network 3 is determined by the rate at which the network is supplied to the folding unit and the rate at which the folded network is discharged from carrier 4. As the reciprocating motion of transport unit 13 is opposed to that of transport unit 15 with guide roller 17, the length of network 3 between discharge point a from transport unit 10, and supply point b on carrier 4 remains constant. This is essential, as otherwise the network would be too taut at one moment and too slack at another, resulting in the chance of the network being folded non-uniformly. Transport unit 13 and transport unit 15 with guide roller 17 always keep network 3 tightly stretched.

In addition, owing to the reciprocating motion of transport unit 15 with guide roller 17, the distance between discharge point b of the network and carrier 4 will remain constant during deposition of network 3 onto carrier 4.

Example 1

Two stretched and fibrillated polypropylene films, each with a thickness of 35 microns and a modulus of 15.000 N/mm^2 at a stretching ratio of 0.1 % and a stretching rate of 5 % per minute are laid one on top of the other and welded together at the sides. This composite film was spread so that the width increased from 8 cm to 90 cm. At this width the network was stabilized by application of heat at a temperature of 150 °C.

The network was next folded zig-zag with an overlap angle of 19°. To this end, the stabilized network was supplied at a rate of 60m/min. The folded network was discharged at a rate of almost 10 m/min in a direction normal to the feeding direction. Together with the folded network 18, stretched, fibrillated and spread reticulate webs made of the above-said composite film were carried off in a longitudinal direction at one side of the folded reticulate webs

The network package thus obtained was then passed between heated rollers (100 °C), coiled and stored.

From the network package thus obtained, a test piece 50 x 50 mm, was cut. The Denier number of this test piece was 160.000 (gr/9000 m). The maximum strength of the piece was 147 kg at a stretching percentage of 18 %. The stretching rate was 100 % per minute. The tenacity was 0,9 gr/denier. Testing at an angle normal thereto yielded the same results.

Example 2

A stretched and fibrillated polypropylene film with a thickness of 50 μm and a modulus of 15000 N/mm^2 at a stretching ratio of 0,1 % and a stretching rate of 5 % per minute was spread from a width of 15 to 90 cm. At this width the network was stabilized by means of heat at a temperature of 170 °C. Next, the network was folded zig-zag with an overlap angle of 11°30'. For this purpose the stabilized network was suppled at a rate of 60 m/min and folded on top of a layer of 7 networks, each with a thickness of 50 μm and a spreading ratio of 1 to 6. The folded network and the added layer of reticulate webs were discharged at a rate of practically 6 m/min in a direction normal to the direction of supply of the network to be folded.

Simultaneously a stretched, fibrillated and spread reticulated web was discharged along at the top side. The resultant network package was then passed between heated rollers (100 °C), coiled and stored. From the network package thus obtained, a test piece 50 x 50 mm, was cut. The Denier number of this test piece was 75000 (gr/9000 m). The maximum strength of the piece was 70 kg at a stretching percentage of 10 %. The stretching rate was 100 % per minute. The tenacity was 1,1 gr/denier. Testing at an angle normal thereto yielded the same results.

CLAIMS

1. Process for the manufacture of network packages from reticulate webs obtained by stretching, fibrillating and spreading of a film of organic polymeric material, characterized in that:
   a. one or more reticulate webs, one on top of the other, are continuously supplied and laid onto a carrier;
   b. the reticulate webs are folded zig-zag on this carrier;
   c. the folded network is continuously transported in a direction virtually normal to the direction in which the reticulate webs are supplied;
   d. further, at one or both sides of the resultant folded network, reticulate webs are applied, which webs are stretched longitudinally and in the direction of transport, fibrillated and spread, and are supplied in the direction of transport of the folded network and joined with it;
   e. the resultant combination of reticulate webs is carried off;

   the rate of supply of the reticulate webs to be folded and the rate of discharge of the folded reticulate webs being chosen so that the angle between two successive folded sides of the reticulate webs is between 1 and 50 °C.
2. Process according to claim 1, characterized in that the angle between two successive folded sides is between 1° and 20°.
3. Process according to claims 1 and 2, characterized in that several of such folded reticulate webs are laid one on top of the other;
4. Process according to claim 1, characterized in that at only one of the two sides of the resultant folded network package, reticulate webs stretched in the transport direction are appled, and at the other side only one or two of such webs.
5. Process according to claims 1-4, characterized in that the resultant folded network packages are integrated into a whole by welds at the sides.
6. Process according to claims 1-5, characterized in that the resultant folded network packages are passed between rollers.
7. Process according to claim 6, characterized in that one or more rollers are heated.

8. Process as substantially described, and represented in the drawing.
9. Network packages manfactured by means of a process referred to in claims 1-8.

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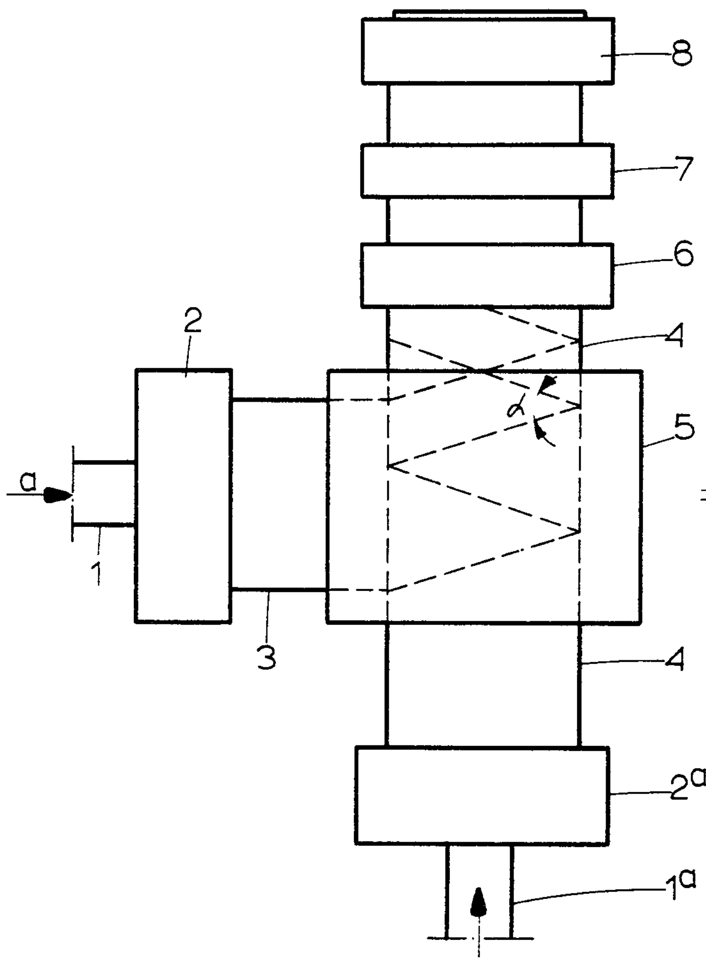

FIG.1

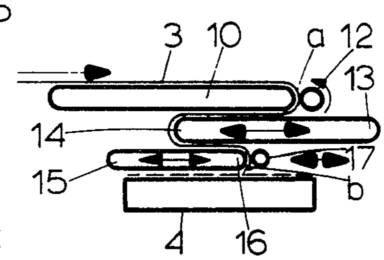

FIG.2

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EUROPEAN SEARCH REPORT

0031624

Application number

EP 80 20 12..

DOCUMENTS CONSIDERED TO BE RELEVANT

Category	Citation of document with indication, where appropriate, of relevant passages	Relevant to claim
A	GB - A - 1 182 674 (CELANESE CORP.) * Page 2, line 96 - page 4, line 12; figures 1,2 * --	1
A	GB - A - 1 244 753 (E.I. DU PONT DE NEMOURS) * Whole document * --	1
A	GB - A - 1 105 968 (CELANESE CORP.) * Page 18, lines 28-52; figure 26 * --	1
A	DE - A - 2 245 872 (K. BOUS) * Whole document * --	1
A	FR - A - 2 160 738 (TEPPICHWERK SCHAEFFLER) * Whole document * --	1
A	GB - A - 1 497 540 (SHELL INTERNATIONALE RESEARCH MAATSCHAPPIJ) * Claims 9-11 * ----	1

CLASSIFICATION OF THE APPLICATION (Int. Cl.)

D 04 H 13/00

TECHNICAL FIELDS SEARCHED (Int. Cl.3)

D 04 H
B 28 B
B 29 D

CATEGORY OF CITED DOCUMENTS

X: particularly relevant
A: technological background
O: non-written disclosure
P: intermediate document
T: theory or principle underlying the invention
E: conflicting application
D: document cited in the application
L: citation for other reasons

&: member of the same patent family, corresponding document

The present search report has been drawn up for all claims

Place of search	Date of completion of the search	Examiner
The Hague	27-03-1981	BOLLEN