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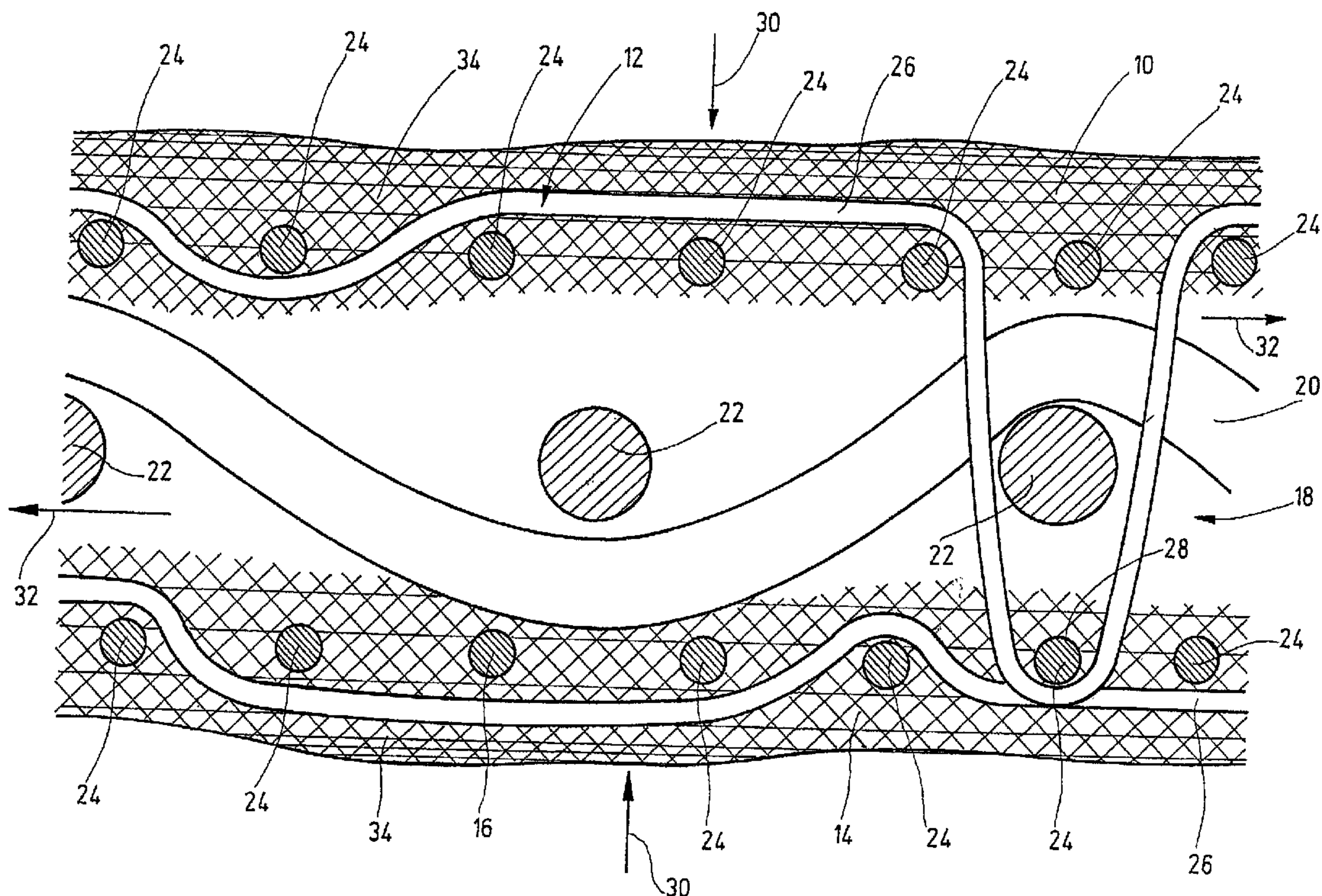
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(54) Titre : **MATERIAU FILTRANT**

(54) Title: **FILTER MEDIUM**



(57) **Abrégé/Abstract:**

The invention relates to a filter medium comprising at least one filter membrane (10) comprising a carcass ply (12) as a supporting and protective layer. At least one additional filter membrane (14) comprising another carcass ply (16) as a supporting and protective layer is also provided. A third carcass ply (18) extends between both adjacent filter membranes (10,14), and both adjacent filter membranes (10, 14) are connected together by the threads (26) of the other two carcass plies (12,16) which reach through to the third carcass ply (18).



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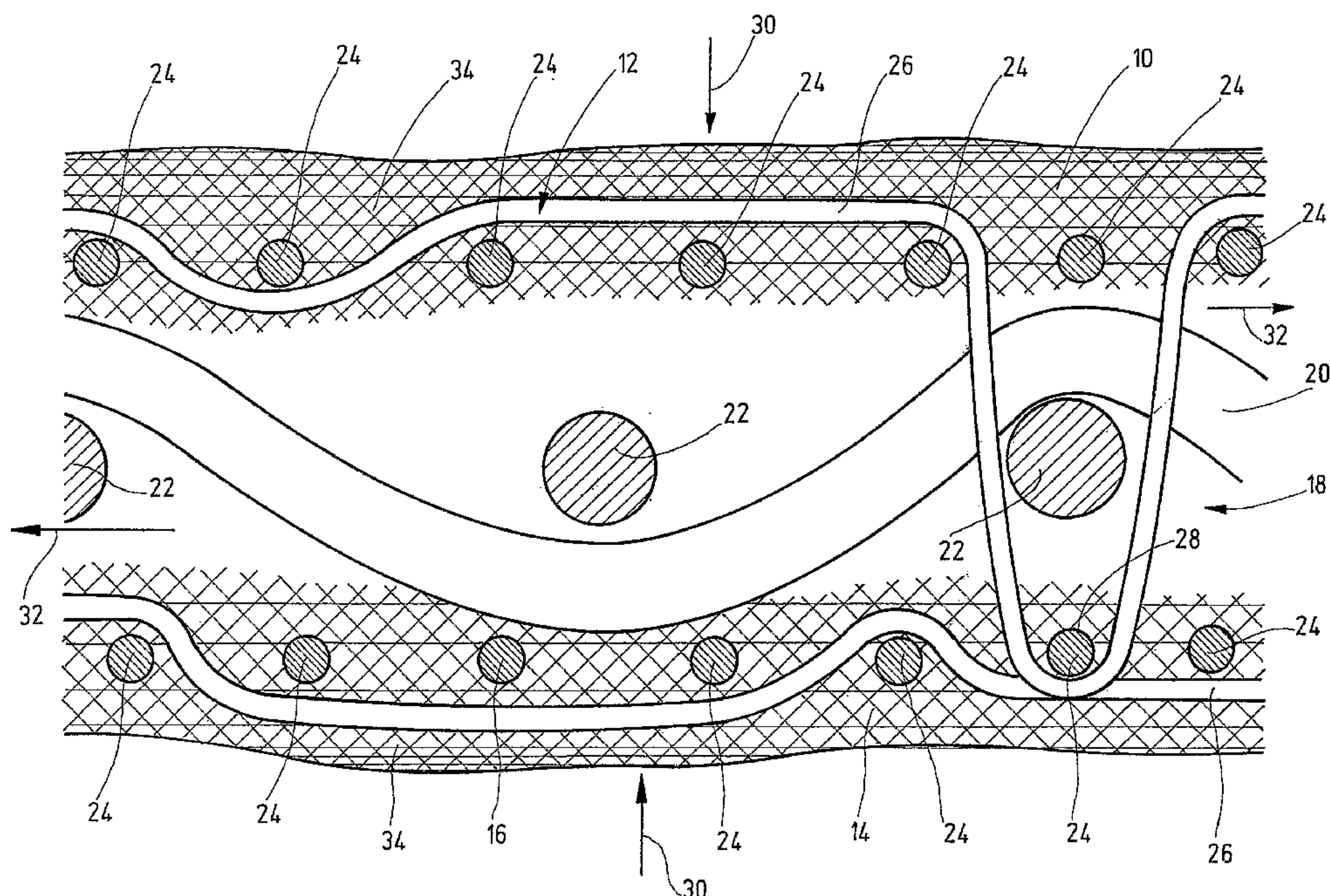
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(54) Bezeichnung: FILTERMEDIUM

(57) **Abstract:** The invention relates to a filter medium comprising at least one filter membrane (10) comprising a carcass ply (12) as a supporting and protective layer. At least one additional filter membrane (14) comprising another carcass ply (16) as a supporting and protective layer is also provided. A third carcass ply (18) extends between both adjacent filter membranes (10,14), and both adjacent filter membranes (10, 14) are connected together by the threads (26) of the other two carcass plies (12,16) which reach through to the third carcass ply (18).(57) **Zusammenfassung:** Die Erfindung betrifft ein Filtermedium mit mindestens einer Filtermembran (10), die eine Gewebelage (12) als Stütz- und Schutzschicht aufweist, wobei mindestens eine weitere Filtermembran (14) mit einer weiteren Gewebelage (16) als Stütz- und Schutzschicht vorhanden ist, wobei

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WO 2005/032699 A1

WO 2005/032699 A1



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Zur Erklärung der Zweibuchstaben-Codes und der anderen Abkürzungen wird auf die Erklärungen ("Guidance Notes on Codes and Abbreviations") am Anfang jeder regulären Ausgabe der PCT-Gazette verwiesen.

sich zwischen den beiden einander benachbarten Filtermembranen (10,14) eine dritte Gewebelage (18) erstreckt und wobei über Fäden (26) der beiden anderen Gewebelagen (12,16), die die dritte Gewebelage (18) durchgreifen, die beiden benachbarten Filtermembranen (10,14) miteinander verbunden sind.

Filter Medium

The invention relates to a filter medium with at least one filter membrane which has a fabric ply as the support and protective layer.

EP 0 761 292 A1 discloses self-supporting capillary membranes for use at higher pressure with an internal separating layer. This known capillary membrane is provided with a seamless outside jacket which is made as a closed, liquid-permeable diagonal reinforcement. The diagonal reinforcement consists of individual threads which consist for their part either of monofilament or multifilaments. The material selection for these monofilaments or multifilaments is almost unlimited, and for example polyester yarns, polyaramides, polymer fibers, glass fibers, or also metal filaments are used. The individual threads of the diagonal reinforcement are applied to the capillaries in a 1:1 to 2:1 or even 2:2 braid binding in a continuous process as a seamless outer jacket. Depending on the wall thickness of the monofilaments or multifilaments, capillaries with outside diameters from 0.5 mm to 15 mm are produced, the capillaries themselves having to have a mechanical stability which resists the thread tension in the reinforcing process. This known capillary membrane can be continuously produced and due to the indicated diagonal reinforcement also has a correspondingly high burst pressure; but still the performance in filtration is limited, and in spite of support by way of the liquid-permeable diagonal reinforcement, in severe filtration operation the membrane material surrounded in this way can fail.

DE 41 42 417 A1 discloses an ion exchanger membrane which, in order to eliminate these disadvantages, calls for reinforcement with a multiaxial, preferably triaxial yarn system, its being considered to be advantageous in a chlor-alkali cell to use an open reinforcing fabric and a thin membrane to obtain low cell tension and good stability for handling of the reinforcing fabric and for the reinforced membrane. A thin membrane in turn requires a thin fabric and low total thickness of the film layers which are used for lamination of the reinforced cation exchanger resin. By definition, an open fabric is one which, when there is illumination from one direction perpendicular to the plane of the fabric, enables a large portion of the incident light to pass through the fabric. This fabric with a high percentage of open points (fabric gaps) is desirable according to the known solution, because the open sites allow the cations to pass from the anolyte to the catholyte in a chlor-alkali process. Thus, an open fabric enables a low cell tension and therefore lower power consumption. The known fabrics in the form of a basket weave or a cross weave are regarded as disadvantageous because on the one hand they lack dimensional stability and on the other have a low modulus and low strength in the oblique direction of the fabric laminate. Accordingly, the known solution proposes a triaxially woven article, that is to say, a fabric which is produced by a weaving process, in which three yarns at an angle of 60° each to one another are used. In particular, if the triaxial fabric is produced from fine yarns, in this way a thin fabric can be obtained which is stable under various loads, even if the fabric has the desired high degree of open sites. The disadvantage in this known solution is that the indicated multiaxial fabric is relatively complex and moreover expensive to produce and thus make the membrane material accordingly more expensive. Furthermore, this solution is likewise limited in filtration performance by its basic structure of the membrane material.

EP 0 355 400 A2 discloses a filter medium for caking filtration processes with a filter membrane which is embedded on either side in a fabric construction which assumes a mechanical protective function. With the known filter medium, also within filter systems in which the filter medium is mechanically loaded to an extremely heavy degree, suspensions can be processed and particles in the submicroporous range filtered out of the fluid flow. In one preferred embodiment of

the known solution the membrane mass can be located between two fabric plies, the membrane mass being applied to a compact, strong carrier fabric ply and a protective fabric ply being embedded into the upper layer of the membrane mass. This protective fabric ply is made as an open-mesh fabric and in this way a sandwich structure for the filter medium for caking filtration processes is achieved. This generic filter-medium has in this way risen to the robust mechanical requirements which are conventionally imposed by filtration technology and especially when the filter cake is removed or discarded is the filter medium exposed to considerable mechanical loads which can be managed with the known filter medium. Still, the filtration performance is not satisfactory even in this durable solution.

On the basis of this prior art, the object of the invention is to further improve the known solutions while maintaining the advantages in the prior art, such that with the solution as claimed in the invention, a filter medium is obtained which ensures high filtration performance with a durable solution for an economical production capacity. This object is achieved by a filter medium with the features of claim 1 in its entirety.

In that, as specified in the characterizing part of claim 1, at least one other filter membrane with another fabric ply is present as the support and protective layer, in that between the two adjacent filter membranes a third fabric ply extends and in that the two adjacent filter membranes are connected to one another via threads of the two other fabric plies which extend through the third fabric ply, a double-sided filter structure is formed, on either side one or more fine fabric layers in the form of the other two fabric plies are applied non-positively to the simultaneously supporting and draining central fabric as the third fabric ply, so that the two outer fabric layers each bear a likewise non-positively connected membrane which makes contact with the medium to be filtered on its outside. Accordingly it is possible to supply the medium to be filtered from both sides, that is to say, from the top and bottom of the double membrane to the latter; this leads to a distinct increase

of the filtration performance and at the same time strong lamination for the double membrane is obtained so that it is also suited for hard use in filtration systems and has a long service life.

The driving force for filtration can be obtained both by filtrate-side negative pressure and also by medium-side overpressure or by a combination of the two. The medium-side crossflow can be achieved by filter-parallel convective flow or by air bubbles or by both. The double-sided filter structure as claimed in the invention is especially well suited for flushing processes in which the driving force is reversed. Furthermore, it is easily possible to apply cleaning chemicals to the filter during backflushing.

The double-sided filter structure as claimed in the invention is preferably produced continuously and the longitudinal edges are sealed during production. In this connection, besides direct encapsulation, techniques such as welding, cementing, beading, knurling, etc., can be used. After completed cutting, the front sides can also be sealed with the indicated techniques or can be cast into transverse tubes by which the filtrate can be withdrawn.

The double-sided filter structure can be used in the most varied geometries. It can be immersed especially as flat vanes into the medium to be filtered; multiple-ply stacked or helical rolling and placement in tubes (stack) are likewise possible.

The solution as claimed in the invention need not be limited to the solution as a double membrane, rather with interposition of other fabric plies a multilayer membrane can be obtained comparably to the third fabric ply in a configuration on top of one another. Moreover, this fabric ply laminate ensures that the individual fabric plies are held against one another even under high stress.

In one preferred embodiment of the filter medium as claimed in the invention, the respective fabric ply consists of warp and weft threads, the fabric plies being joined via additional binding threads which change at least one binding point from the fabric ply of one filter membrane into the adjacent fabric ply of the other filter membrane; or in alteration from one of the two outer fabric plies into the adjacently arranged third fabric ply. Via the additional binding thread system, without disrupting the actual fabric structure, a reliable combination for the filter medium can be achieved and at the same time the fabric plies of the filter membranes are provided with a high percentage of open passage sites so that a fluid flow can enter the filter structure which has open pores without hindrance. By preference provision may be made such that the fabric ply of the respective filter membrane consists of weft threads as a cross thread system and that the longitudinal thread system is made up solely of binding threads as warp threads.

In another embodiment of the filter medium as claimed in the invention, the fabric ply of the respective filter membrane is made up of warp and weft threads, the weft threads producing the connection of the adjacent filter membranes as they extend through the other fabric ply. In this configuration a very reliable, highly loadable laminate of fabric plies with one another is achieved; this however burdens the open structures of the filter membranes with the fabric plies assigned to it.

In another, especially preferred embodiment of the filter medium as claimed in the invention, the warp and weft threads of the third fabric ply are dimensioned thicker in diameter than the threads of the two adjacent fabric plies used with the filter membranes. Based on this configuration, it is possible to make the middle third fabric ply coarse as a support and drainage fabric, so that in this way filtrate discharge for the filter medium is largely ensured, conversely the filter membranes have the structure of a fine fabric layer with an open-pore structure.

In another preferred embodiment of the filter medium as claimed in the invention, the threads used are formed from a polyester or a polyamide material, and for the capillary membrane

material a polymer material is used, preferably in the form of polyether sulfone (PES), polysulfone (PSU), polyacrylonitrile (PAN), polyvinylidene fluoride (PVDF). Preferably the polymer material consists of polysulfone which is obtained in solutions by extrusion and setting by means of contact with water.

In another preferred embodiment of the filter medium as claimed in the invention, it is made as a flat filter material. The longitudinal tensile stresses which occur during filtration are accommodated by the longitudinal fibers which run through, the stresses on the periphery being reliably accommodated by the transversely running threads of the fabric ply laminate. This reduces the shifting of the threads against one another so that unwanted stretching effects during coating of the membrane material are distinctly minimized and the filtration capillary which has been fabric-reinforced in this way resists very high internal pressure and longitudinal tensions. As the thread thickness, threads with a diameter from 20 to 200 microns can be used and the number of threads is 3 to 6. The selected angle of the transverse threads is preferably between 45° to 90° and the inside diameter is 1 mm to 20 mm.

The filter medium as claimed in the invention is detailed below using a single drawing which shows schematically and not to scale a side view in the form of a cross section relative to an extract of the filter medium.

The filter medium as claimed in the invention has an upper filter membrane 10 with a fabric ply 12 as the support and protective layer. Furthermore, the filter medium has another lower filter membrane 14 with another fabric ply 16 as the support and protective layer. A third fabric ply 18 runs between the two adjacent filter membranes 10, 14. This third fabric ply 18 consists of a thread system of warp threads 20 and weft threads 22. The warp threads 20 form the longitudinal fiber system and the weft threads form the transverse thread system of the third fabric ply 18. Fundamentally it is also possible to interchange the indicated longitudinal and transverse thread

system such that the indicated warp threads 20 form the weft thread system and the weft threads 22 form the warp thread system. The upper fabric ply 12 and the lower fabric ply 16 are likewise composed of a longitudinal and a transverse thread system consisting of individual warp threads (not shown) and weft threads 24. As the figure furthermore shows, by way of threads 26 which are made as binding threads, the two fabric plies 12, 16 are connected to one another, the pertinent threads 26 extending through the third fabric ply 18. If the fabric ply 14 has additional binding threads 26, they change at least one binding site 28 from the fabric ply of one filter membrane 10 into the adjacent fabric ply 16 of the other filter membrane 14. As the figure shows, the binding site 28 is formed by the binding thread 26 of the upper fabric ply 12 leaving the latter, viewed in the direction of looking at the figure, and in the process extending under the weft thread 22 (cross thread) of the third fabric ply 18 at the point at which the warp thread 20 (longitudinal thread) extends over the weft thread assigned to it, at the indicated binding site 28 the weft thread 24 of the upper filter membrane 10 being kept free of the changing lamination with the assigned binding thread 26 and its extending under the underlying weft thread 24 of the other lower filter membrane 14. Otherwise the weft threads 24 of the two filter membranes 10, 14 form one thread-bearing bridge at a time for the binding threads 26 which in this respect extend over or under three weft threads 24 before being changed in the direction of the binding site 28 or the following weft thread 24 of the upper fabric ply 12 or the lower one being passed under or over.

In another alternative embodiment (not shown), it can also be possible to replace the longitudinal threads which are not shown in the upper and lower fabric ply lamination 12, 16 solely by the binding threads 26; this does reduce the strength of the lamination; otherwise it leads to an open-pore fabric structure for the respective filter membrane 10, 14. It would also optionally be possible to form only one of the filter membranes 10 or 14 in this way. Furthermore, in an embodiment of the filter medium as claimed in the invention which is not shown, it is also possible to omit the binding threads 26 and to produce the lamination by way of the longitudinal threads of

the respectively upper and lower fabric ply 12 and 16 which then change crosswise in this way through the third fabric ply 18.

The warp threads 20 and the weft threads 22 of the third fabric ply 18 are dimensioned thicker in diameter than the thread systems of the two adjacent fabric plies 12, 16 used with the filter membranes 10, 14. This yields a very stiffly made support and drainage fabric for the third fabric ply 18 and at the same time the filtrate can be discharged by way of the relatively open structure with a channel cross section which is dimensioned to be large in diameter on either side of the double membrane above and below of the longitudinal thread system 20, if, according to the partial representation as shown in the figure, the medium to be filtered at the time enters the double membrane structure on either side from the top and from the bottom. The parts of the flow of medium are shown with 30 and those of the filtrate flow are shown with 32.

The threads used for the individual fabric plies 12, 16, 18 consist preferably of a polyester or polyamide material, the membrane material 34 itself consisting of a polymer material, preferably of polysulfone (PSU) which is formed in solution by extrusion and setting by means of contact with water.

The filter medium as claimed in the invention can be made as a flat filter material, but also as tubular material. For this purpose, longitudinal tensile stresses can be reliably accommodated by the longitudinal threads which run through can be reliably accommodated and stresses on the periphery are reliably accommodated by the transversely running threads (weft threads 24). The respective looping reduces the displacement of the thread systems against one another and the unwanted stretching effect during coating is minimized, the filtration capillary which has been fabric-reinforced in this way resisting very high internal pressures and longitudinal tensions. Various exemplary embodiments of the carrier-supported tubular membrane when using polysulfone for the membrane material have resulted in that for porous tubes with a diameter of 8

mm inside and 10 mm outside, tensile strengths of 3 to 4 N/mm² at a breaking elongation of 20% are achieved and in a dynamic pressure test these tubes have withstood a burst pressure of a maximum 1.5 bar.

If for the purposes of the invention the same solution is produced together with diagonally braided hoses homogeneously extruded with the same dimensions of 8 mm inside and 10 mm outside, tensile strengths of 20 N/mm² at a breaking elongation of 50% arise and in the dynamic pressure test these tubes withstood a burst pressure of 10 bar. But shortening of the tube by approximately 10% is observed, the pertinent shortening force leading to strong loading of the retaining device of the tubes, which in the extreme case yield tensile forces up to 500 kg; this leads to deformations and to tearing out of the parts of the retaining device.

If the same solution with hoses braided twice diagonally is homogeneously extruded with the same dimensions, the tensile strength is 50 N/mm² at a breaking elongation of 20% and in the dynamic pressure test these tubes withstood a burst pressure of 10 to 15 bar, but in turn a shortening of the pipe of 5% being observed.

The indicated warp threads, the weft threads and the binding threads can consist of different polymers in order in this way to be able to optimize the mechanical strength and the chemical resistance to the application independently of one another. In this connection, especially chemically inert polypropylene materials or very stable polyetherether ketone materials are possible.

C l a i m s

1. Filter medium with at least one filter membrane (10) which has a fabric ply (12) as the support and protective layer, characterized in that at least one other filter membrane (14) with another fabric ply (16) is present as the support and protective layer, that between the two adjacent filter membranes (10, 14) a third fabric ply (18) extends, and that the two adjacent filter membranes (10, 14) are connected to one another via threads (26) of the two other fabric plies (12, 16) which extend through the third fabric ply (18).
2. The filter medium as claimed in claim 1, wherein the respective fabric ply (12, 16, 18) consists of warp and weft threads (20, 22; 24) and wherein the fabric plies are joined via additional binding threads (26) which change at least one binding point (28) from the fabric ply (12) of one filter membrane (10) into the adjacent fabric ply (16) of the other filter membrane (14).
3. The filter medium as claimed in claim 1 or 2, wherein the fabric ply (12, 16) of the respective filter membrane (10, 14) consists of weft threads (24) as a cross thread system and wherein the longitudinal thread system is made up solely of binding threads (26) as warp threads.
4. The filter medium as claimed in claim 1, wherein the fabric ply (12, 16) of the respective filter membrane (10, 14) is made up of warp and weft threads and wherein the weft threads as they extend through the other fabric ply (18) produce the connection of the adjacent filter membranes (10, 14).

5. The filter medium as claimed in one of claims 1 to 4, wherein the warp and weft threads (20, 22) of the third fabric ply (18) are dimensioned thicker in diameter than the threads of the two adjacent fabric plies (12, 16) used with the filter membranes (10, 14).
6. The filter medium as claimed in one of claims 1 to 5, wherein the threads (20, 22, 24, 26) used consist of a polyester or a polyamide material and wherein the membrane material (34) is formed from a polymer material.
7. The filter medium as claimed in one of claims 1 to 6, wherein it is made as a flat filter material or as tubular material.

