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(54) **Air permeable rain barrier comprising slanted capillary apertures**

(57) The present invention relates to rain protection and rain barrier articles like raincoats, roof liners for buildings or tents and other protection covers intended to prevent entry of rainwater. According to the present invention the articles are provided with or by at least one breathable layer of a resilient, three dimensional web

(55) which consists of a liquid impervious polymeric film having apertures (53). These apertures (53) form capillaries which are not perpendicular to the plane of the film but are disposed at an angle of less than 90° relative to the plane of the film and installed to retard entry of rain.

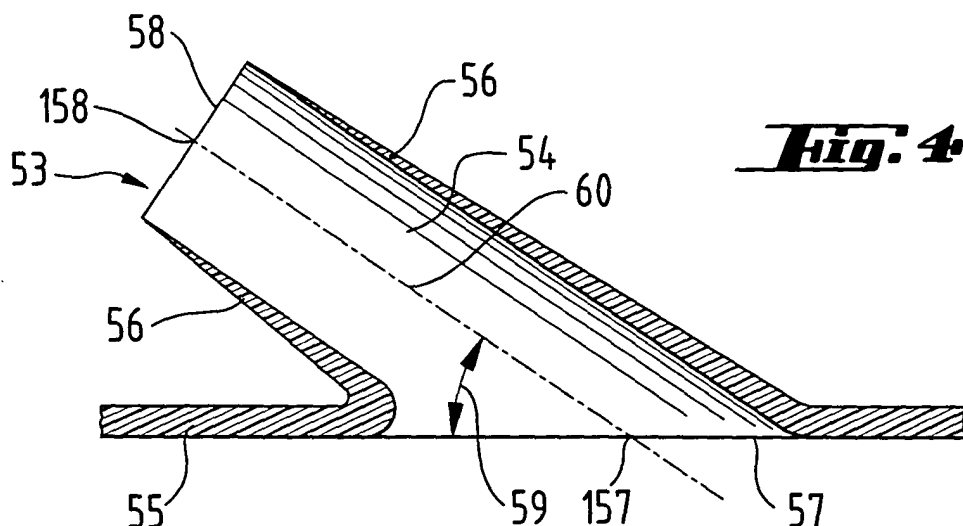


Fig. 4

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DescriptionField of the invention

[0001] The present invention relates to rain protection and rain barrier articles like raincoats, roof liners for buildings or tents and other protection covers intended to prevent entry of rainwater. According to the present invention the articles are provided with or by at least one breathable layer of a resilient, three dimensional web which consists of a liquid impervious polymeric film having apertures. These apertures form capillaries which are not perpendicular to the plane of the film but are disposed at an angle of less than 90° relative to the plane of the film and installed to retard entry of rain.

Background of the Invention

[0002] Primary need of rain barrier or rain protection articles is to prevent passage of rainwater through the article. For example in the case of roof liners, that is the material installed on top of the wooden roof construction but below the tiles in order to prevent exposure of the wooden roof construction to moisture, water entry can only come from rain water which does always fall from above, (or under windy conditions with an angle). However no surface of the roof construction would usually be exposed to rain water from below (in a gravitational sense). The same is of course true for camping tents. Another possible use of barriers is for walls of buildings which are exposed to rain water seeping through the soil.

[0003] Such barriers are disclosed for example in EP-A-704 297 in which completely impermeable coatings (oil and water) to outsides of cellar walls are disclosed.

[0004] According to the present invention it has therefore been recognized and utilized in conceiving the present invention that exposure to rain water will always happen in a directional sense such that a directionality of a water barrier can be utilized.

[0005] There are other rain barrier or protection articles in which similar considerations can be applied. In particular rain wear (reusable or disposable) for people will also have regions which are exposed to rain from a constant or almost constant direction. Another usage for the articles according to the present invention would be protective covers against directional liquid exposure such as can be found in the agricultural field when spraying chemicals (fertilizer or other plant treatments). A further usage situation for the articles according to the present invention would be disposable outer liners for cars, cycles or shipment packages for example in the agricultural field or for the transportation industry.

[0006] Rain barrier or protection articles satisfying the above objectives are of course already known in the form of water impermeable polymeric films. Such films have the benefit of not being directional i.e. the installation or usage thereof is independent of the direction from which water will impact. However they also suffer a tremendous drawback from causing an occlusion to airborne humidity such as water vapor but also other airborne materials such as dust particles. Conventionally the occlusion is accepted to achieve protection against rain water entry. Articles having water vapor transport characteristics such as Gore Tex (RT) or other microporous film materials are already well known. However they do not allow free air circulation and therefore have a very slow water vapor transport capability. On the other hand eliminating occlusion could be achieved by apertured film materials which are however not satisfactory in respect to their barrier function.

[0007] Therefore the intended benefit of the rain protection articles according to the present invention is the ability to allow water vapor and air to freely pass in and out through the barrier while the rain protection function is kept. It has now been found that this can be achieved by use of the principles disclosed in WO97/03818, WO97/03795 or US-A-5.897.543 to design the special breathable rain barrier according to the present invention. It is therefore an objective of the present invention to provide rain barrier articles which allow free air circulation through them while at the same time preventing or at least minimizing water transmission of water deposited primarily in a designated direction, such as rain. At the same time reapplication of known and proven manufacturing processes and equipment is desirable for economic reasons. Satisfying this objective as well as other benefits of the present invention will become readily apparent when considering the summary of the invention and the detailed description thereof.

Summary of the invention

[0008] The present invention relates to airpermeable rain protection articles. Rain protection articles are those articles which are intended to protect a wearer or a thing against becoming wet from rain. Rain protection in this sense also provides protection from being exposed to chemicals or dirt conventionally contained in rain or chemicals contained in sprayed liquid having a designated direction (such as fertilizer or fungicides in agricultural use). Examples of rain protection articles are rain coats, roof liners and wall liners in construction, tents, car or packaging materials in the agricultural field or the transportation industry.

[0009] According to the present invention the rain protection articles can be reusable for example in rain coats or disposable such as for example in rain protection capes. They can of course also be intended for longterm, permanent use such as roof liners or wall liners on buildings.

[0010] The rain protection article according to the present invention has the particular benefit and characteristic of being airpermeable. Airpermeability is important for clothing but also for example in the building industry to allow for water vapor to escape through a roof or wall while still providing the rain protection performance.

[0011] Of course both objectives are not compatible since airpermeability usually also results in a loss of liquid imperviousness. Therefore the present invention utilizes the phenomenon of rain water having a designated direction relative to the surface of the protection material.

[0012] According to the present invention the rain protection article comprises a resilient three dimensional layer which has a first and a second surface. The second surface is that which is exposed to rain while the article is used for rain protection. The layer consists of a liquid impervious polymeric film with apertures which are formed by capillaries. The capillaries allow the free air exchange between the first and the second surface of the liquid impervious film. The capillaries have side walls which extend away from the second surface of the film and the capillaries have a first opening in the first surface of the film and a second opening at the end of the capillary which is spaced apart from the second surface of the film.

[0013] According to the present invention the capillaries extend away from the second surface of the film at an angle which is less than 90° relative to the plain of the film and the angle points the capillaries away from that direction from where rain falls during usage of the rain protection article.

[0014] In a preferred embodiment all capillaries in the film are substantially identical and preferably homogeneously distributed across the film. The angle at which the capillaries extend away from the second surface of the film is preferably between 85 ° and 20°, more preferably between 65 ° and 25° and most preferably between 55° and 30°. The shape of the capillaries is most preferably such that they form cones in which the opening in the first surface of the film is larger than at the end of the capillaries. In an alternative embodiment or in combination with the cones the capillaries can be curved so as to direct the second opening again towards the second surface of the film.

[0015] According to the present invention the open area for conducting air through the film should provide a effective airpermeability. In this respect it is desirable to have such an open area of at least 5 %, preferably at least 10%, most preferably at least 15 %, measured on the basis of the area of the first surface of the film for conducting air between the two surfaces of the film.

[0016] At the same time a reduction of the surface effects within the capillaries retarding the free airflow can be achieved by minimizing the capillary wall surface area relative to the cross section area available for airpermeation. That would conventionally result in circular capillaries or cones having a circular cross section. Of course the size of the capillaries is important. The first opening of the capillaries measured within the plain of the film has been found to be preferably in the range between 1-20 mm², preferably 3-10 mm² and most preferably 5-8 mm².

[0017] The film material alone can most preferably be used as roof liner or for disposable rain coats or capes. For reusable rain coats a combination with other layers such as non wovens or woven material has been found more appealing since the direct skin contact (even with small areas of polymeric film) often causes the sensation of sweatiness. In this context it is also possible that the film material is microporous as starting material so as to allow at least water vapor transport in regions where no apertures are present, thus combining the benefits of air permeability with water vapor permeability while maintaining rain protection.

Brief description of the drawings

[0018] Figure 1 shows a photocopy representation of the first surface of a film useful in the articles according to the present invention.

[0019] Figure 2 shows a photocopy representation of the second surface of the film useful in articles according to the present invention.

[0020] Figures 3 through 7 show particular alternative embodiments of the capillaries used for the film useful in articles according to the present invention.

Detailed description of the invention

[0021] In the following the air permeable rain protection article according to the present invention will be exemplified as a disposable rain coat. Other articles as mentioned above utilize however the same principles for providing air permeability and rain protection and their detailed construction will be readily apparent to those skilled in the art.

[0022] According to the present invention suitable airpermeable rain coats comprise a resilient three dimensional layer which consists of a liquid impervious film which has apertures and is air permeable. The film is oriented such that it retards or prevents rain droplets and water running down on the rain coat from passing towards the inside while

allowing free air flow through it.

[0023] According to the present invention any additional layer of the rain coat needs to provide at least air permeability in order to improve the comfort benefit from the breathability of the article. In this context suitable water vapour and air permeable layers include two-dimensional micro- or macro-apertured films, which can also be micro-or macroscopically expended films, formed apertured films and monolithic films, as well as nonwovens, or wovens. Such films and film materials are disclosed in detail e.g. in EPO 293 482 and the references therein, or US 3, 929,135, US 4 637 819 and US 4 591 523.

[0024] The film layer according to the present invention provides air and water vapour permeability by being apertured. Preferably this layer is made in accordance with the aforementioned US-A-5,591,510 or PCT WO- 97/03818, WO-97/03795. In particular, this layer comprises a polymeric film indicated in figure 1 and 2 as layer (55), having capillaries (54). The capillaries extend away from the second surface of film (55) at an angle which is less than 90 degrees. In figure 3 through 7 alternative embodiments of such capillaries are shown. Preferably the capillaries are evenly distributed across the entire surface of the layer, and are all identical. However, articles having only certain regions provided with apertures, for example only in the regions which are substantially vertical such as the arm portions of a coat or excluding zones which are substantially horizontal such as the shoulder portions, could be provided with a film in which only selected regions have capillaries according to the present invention or with an additional impermeable layer in regions where permeability is not desired.

[0025] Methods for making such three-dimensional polymeric films with capillary apertures are identical or similar to those found in US 3 929 135, US 4 151 240, US 4 319 868, US 4 324 426, US 4 343 314, US 4 591 523, US 4 609 518, US 4 629 643, US 4 695 422 or WO 96/00548, US 5 591 510 or WO 97/03118 and WO 97/03795. Typically a polymeric film such as a polyethylene (LDPE, LLDPE, MDPE, HDPE or laminates thereof) is heated close to its melting point and exposed through a forming screen to a suction force which pulls those areas exposed to the force into the forming apertures which are shaped such that the film is formed into that shape and, when the suction force is high enough, the film breaks at its end thereby forming an aperture through the film. Other film materials include PVC, polypropylene, polyesters, polyethers, polyvinyl alcohols and other such as monolithic polymer film e.g. Hytrel™ film from DuPont, Corporation, USA. Films can also be treated to have an increased water repellency e.g. by Teflon™, silicone, or other fluoride coatings or by residue integrated hydrophobicity increasing compounds such as fluoro carbons.

[0026] Various forms, shapes, sizes and configurations of the capillaries are possible and will be discussed in reference to figures 3 through 7 in the following. The apertures (53) form capillaries (54) which have side walls (56). The capillaries extend away from the wearer facing surface of the film (55) for a length which typically should be at least in the order of magnitude of the largest diameter of the aperture while this distance can reach up to several times the largest aperture diameter. The capillaries have a first opening (57) in the plane of the first surface of the film (55) and a second opening (58) which is the opening formed when the suction force (such as a vacuum) in the above mentioned process creates the aperture. Naturally the edge of the second opening (58) may be rugged or uneven, comprising loose elements (70) extending from the edge of the opening as shown in Fig. 2 and 3. However, it is preferred that the opening be as smooth as possible so as not to create a capillary liquid transport force between the extending elements at the end of the second opening (58) and the capillary (54) aperture (53).

[0027] As shown in figure 4 the first opening has a center point (157) and the second opening also has a center point (158). These center points for non-circular openings are the area center points of the respective opening area. When connecting the center point (157) of the first opening (57) with the center point (158) of the second opening (58) a center axis (60) is defined. This center axis (60) forms an angle (59) with the plane of the film which is the same plane as the first surface of the film (55). This angle should be preferably in the range between 85 and 20 degrees, more preferably between 65 degrees and 25 degrees, and most preferably between 55 and 30 degrees.

[0028] It is of course possible to allow the capillaries to take the shape of a funnel such that the second opening (58) is (substantially) smaller than the first opening (57) when considering the opening size in a plane perpendicular to the center axis (60). Such an embodiment is shown in figure 3. In figure 5 another embodiment of the capillaries useful for the present invention is shown which is curved along its length towards the second surface of the film (55).

[0029] In figure 6 another preferred embodiment of a capillary according to the present invention is shown which has a first portion (257) and a second portion (258). The first portion (257) of the capillary is different in direction than the second portion (258) of the capillary (54). This difference can also be in shape, size, and form of the portions of the capillary in order to achieve the desired level of airpermeability while preventing liquid passage through the film. Such an example is shown in figure 7. It should be noted that the second opening, in accordance with the present invention, has to be directed away from the incident direction of rain.

[0030] Without wishing to be bound by theory it is believed that the capillaries according to the present invention in the film layer of the breathable backsheet allow air and water vapour permeability which is not hindered by them being slanted at an angle or by the shape as indicated above. At the same time the slanting and shaping according to the present invention will prevent or hinder liquid transport through the capillaries towards the inside of the article due to

gravitational force.

Examples

[0031] The polyethylene film shown in figures 1 and 2 was used to compare the rain resistance relative to an umbrella nylon fabric. The test is conducted in accordance with ASTM D3379 which is the standard test method for rain wear. The test was conducted using a water resistance rain tester 35-1994 as a standard instrument developed by the American Association of Textile Chemist and Colorist (AATCC). This instrument is also used to investigate umbrella fabrics which are however usually tested according to ASGM D4112 as the standard test setup.

[0032] Basically the instrument measures the resistance of a fabric or combination of fabrics to the penetration of water by impact to predict the rain penetration (or lack thereof). The water penetration is indicated by the increase in weight of water penetrating through the test fabric. The test is performed at different head pressures (rain strength)

short shower: 30 seconds from 60 mm height

usual rain: 2 minutes from 60 mm height

rain storm: 5 minutes from 950 mm height.

[0033] In the table below a combination of two layers of the polyethylene film according to figure 1/2, one layer of the film according to figure 1/2 together with a polypropylene nonwoven, a film according to figure 1/2 sandwiched between two layers of polypropylene nonwoven and an umbrella fabric were tested. The multilayered structure including the film according to figure 1/2 were laminated without adhesive between them but just held together along their periphery overlaying each other.

Table 1

	film plus film	film plus nonwoven	nonwoven plus film plus nonwoven	Nylon fabric from an umbrella
the simulated rain was incident onto the:	film	film	nonwoven	conventional umbrella fabric outside
rain shower	0	0	0	3g
usual rain	0	0	0	> 5g *
rain storm	0.25	0	0	> 5g *
Results measured according to ASTM D3779 in g, lower values mean lower barrier function. (*) Results of more than 5 gram are not measured but reported as failure.				

[0034] When considering breathability it is of course apparent that a completely liquid, air and water impermeable polymeric film will have best performance for rain penetration. It would thus be as good as any of the laminates above, however without providing air breathability. Also the benefit of water vapor permeability as achieved by microporous films or breathable monolithic films is substantially less than the water vapor transport achievable through airpermeable surfaces.

[0035] According to the present invention the rain protection article can be used beneficially in the context of rain coats, roof barriers and all the other articles mentioned supra. It is therefore apparent to the skilled person that the respective rain barrier article should also have all those features and parts which are typical for products in the context of their intended use.

[0036] As an alternative to the above use of the resilient three dimensional polymeric film it is also possible, particularly in the context of personal rain protection garments, to have some or all capillaries extend from the first surface of the film. In such a case the capillaries also allow free air circulation and extend from the first surface at an angle of less than 90° measured from the plain of the film. However the angle needs to direct the capillaries in an upward direction i.e., substantially against the gravitational force vector. Preferably the capillaries are such that the opening in the second surface, which is exposed to rain is not larger than the opening at the end of the capillaries in order to prevent a capillary pumping surge action directed against gravitational forces.

[0037] The primary benefit of this alternative is that the capillaries when extending from the first surface are on the inside of the rain protection article. Thereby any internal squeezing of the film surface causes the capillaries to temporarily collapse and close. Especially for rain coats or caps this allows to provide the whole article with capillaries e. g. under arms or on shoulders. It also provides a smooth outside which is appealing and the loose elements pointing to the inside reduce/prevent the appearance and sensation of plain plastic film touching the skin (for articles without

inner liner) which is otherwise known to cause rejection of polymeric film garments.

Claims

1. Airpermeable rain protection article comprising a resilient three dimensional layer, said layer having a first surface and a second surface, said layer consisting of a liquid impervious polymeric film (55) having apertures (53), said apertures (53) are forming capillaries (54), said capillaries (54) allow air permeation between said first and said second surface of said film (55), said capillaries (54) have side walls (56) which extend away from said second surface of said film (55), said capillaries (54) have a first opening (57) in said first surface of said film (55) and a second opening at the end of said capillaries (54) spaced apart from said second surface of said film (55) and said capillaries (54) extend away from said second surface of said film (55) at an angle of less than 90° measured from the plain of said film (55) said article being characterized in that under usage conditions said second surface is exposed to rain and said angle points said capillaries away from the direction from where rain falls.
2. Article according to claim 1 characterised in that said capillaries (54) are all substantially identical, preferably said capillaries (54) are homogeneously distributed across said film (55).
3. Article according to any of the preceding claims characterised in that said angle is between 85° and 20°, preferably between 65° and 25°, most preferably between 55° and 30°.
4. Article according to any of the preceding claims characterised in that said capillaries form cones having a larger opening in said first surface than at the end of said capillaries (54).
5. Article according to any of the preceding claims characterised in that said capillaries (54) are curved towards said second surface of said film.
6. Article according to any of the preceding claims characterized in that the area open for conducting air is at least 5 %, preferably at least 10 %, most preferably at least 15 % of the area of the first surface of said film (55).
7. Article according to any of the preceding claims characterized in that the size of said first opening, measured in the plain of said film is in the rang of 1-20 mm², preferably 3-10 mm² and most preferably 5-8 mm².
8. Article according to any of the preceding claims characterized in that it is a roof lining.
9. Article according to any of the claims 1 to 7 characterized in that it is a disposable rain coat.
10. Airpermeable rain protection article comprising a resilient three dimensional layer, said layer having a first surface and a second surface, said layer consisting of a liquid impervious polymeric film (55) having apertures (53), said apertures (53) are forming capillaries, said capillaries allow air permeation between said first and said second surface of said film (55), said capillaries have side walls which extend away from said first surface of said film (55) said capillaries have a first opening in said second surface of said film (55) and a second opening at the end of said capillaries spaced apart from said first surface of said film (55) and said capillaries extend away form said first surface of said film (55) at an angle of less than 90° measured from the plain of said film (55) said article being characterized in that under usage conditions said second surface is exposed to rain and said angle points said capillaries substantially against the gravitational force vector.

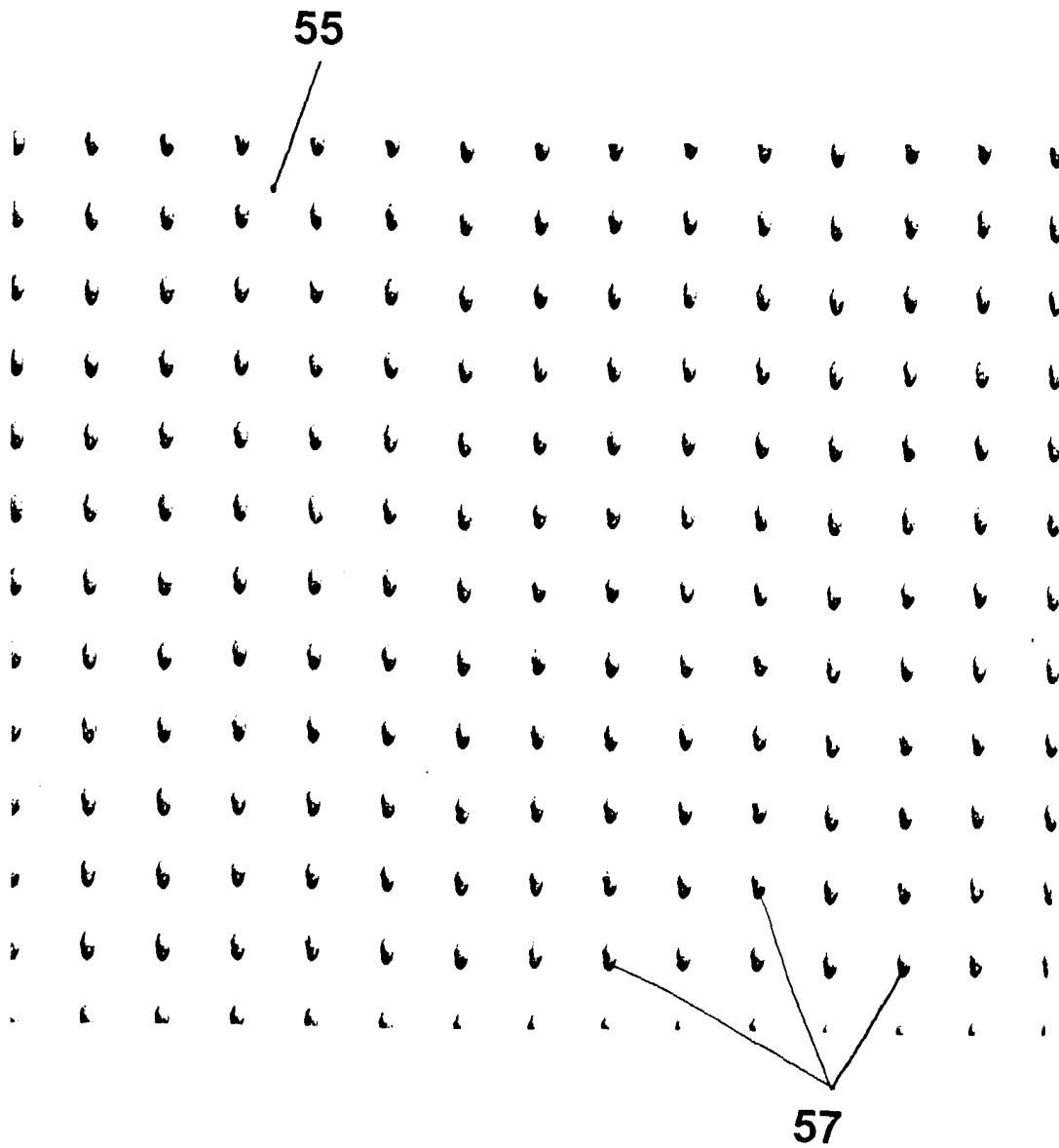


Figure 1

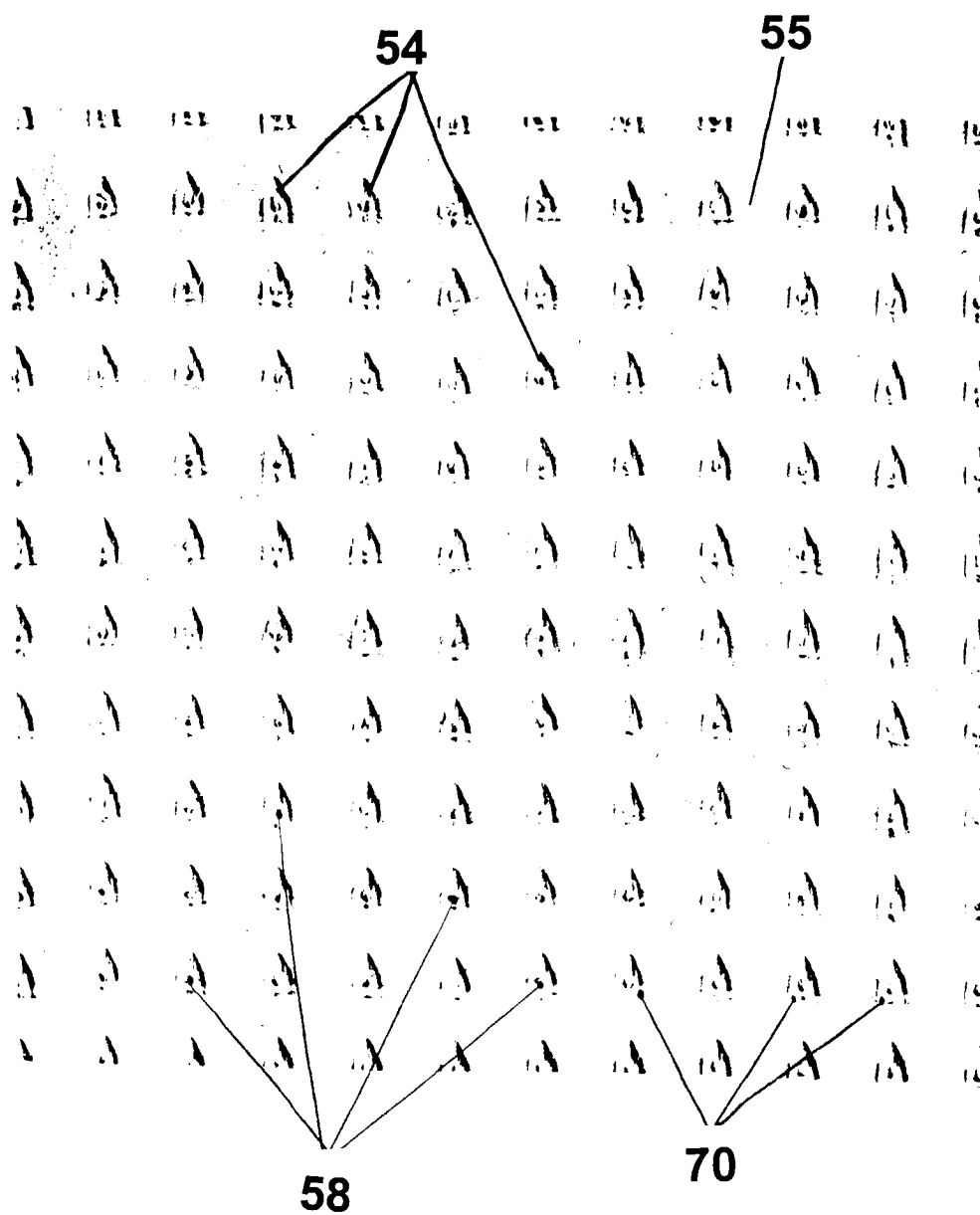
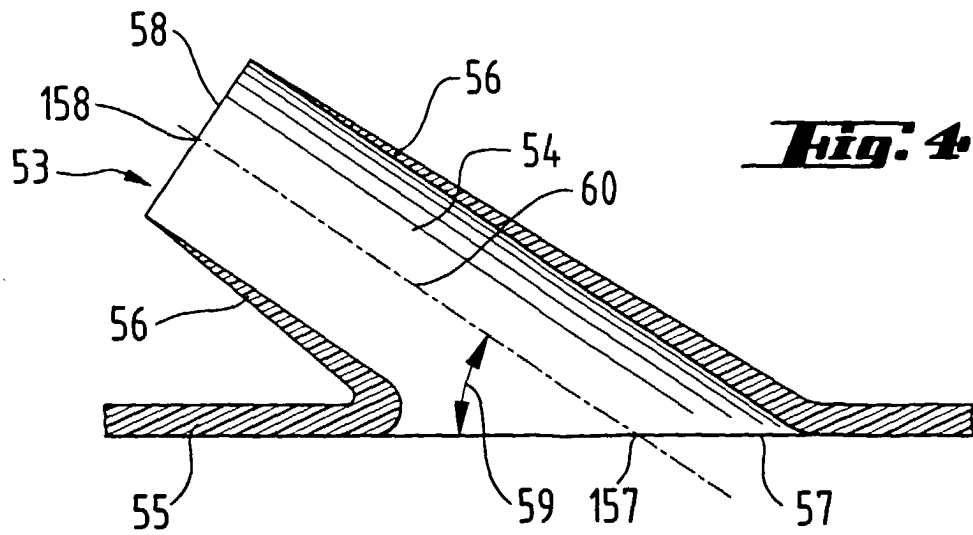
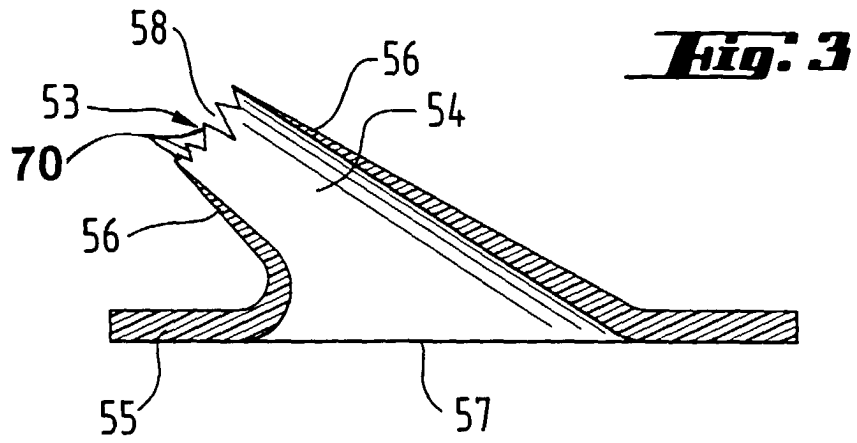
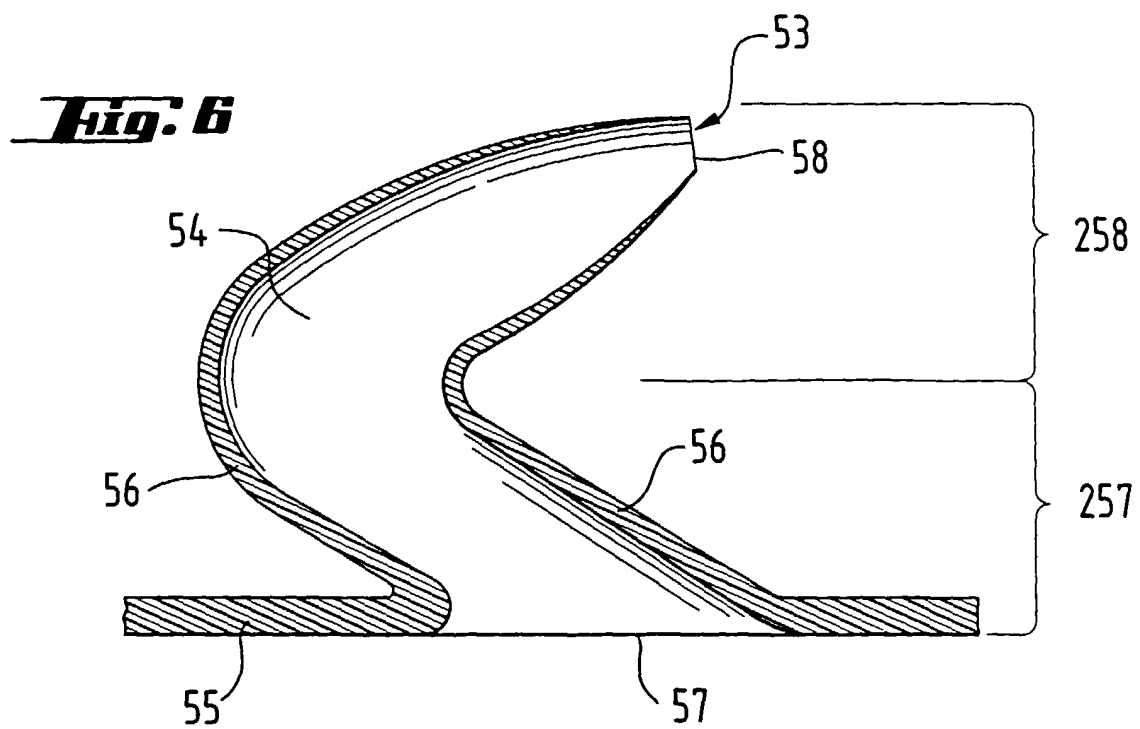
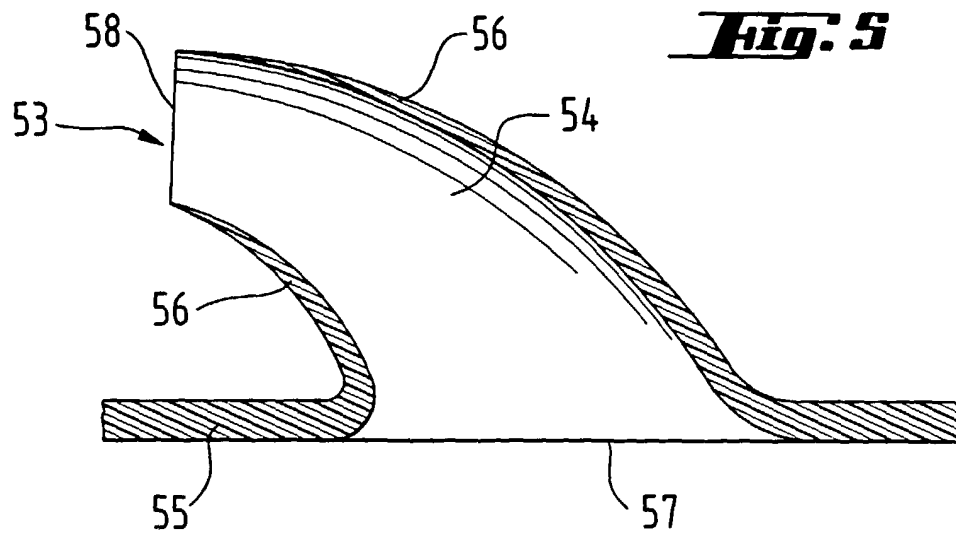


Figure 2





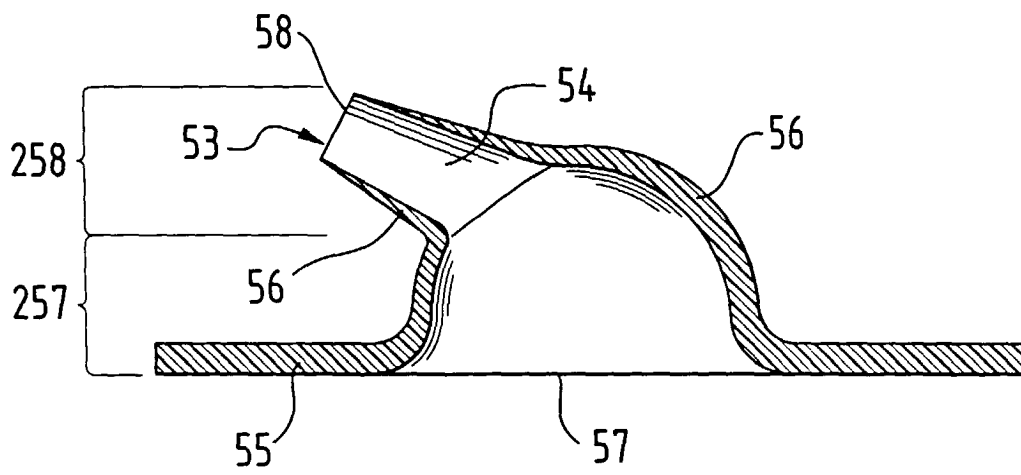


Fig. 1



European Patent
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EUROPEAN SEARCH REPORT

Application Number
EP 99 11 2868

DOCUMENTS CONSIDERED TO BE RELEVANT			
Category	Citation of document with indication, where appropriate, of relevant passages	Relevant to claim	CLASSIFICATION OF THE APPLICATION (Int.Cl.7)
Y,D	WO 97 03818 A (TREDEGAR INDUSTRIES INC.) 6 February 1997 (1997-02-06)	1,10	A41D31/00 A41D3/04
A	* claims 1-12; figures 4-8 *	2-5	
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			TECHNICAL FIELDS SEARCHED (Int.Cl.7)
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The present search report has been drawn up for all claims			
Place of search THE HAGUE		Date of completion of the search 13 March 2000	Examiner Garnier, F
CATEGORY OF CITED DOCUMENTS		T : theory or principle underlying the invention E : earlier patent document, but published on, or after the filing date D : document cited in the application L : document cited for other reasons & : member of the same patent family, corresponding document	
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EP 99 11 2868

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For more details about this annex : see Official Journal of the European Patent Office, No. 12/82