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[32] Priority **Dec. 27, 1967**
[33] **Germany**
[31] **P 16 80 500.8**

[54] **PROTECTIVE MAIL MESH**
60 Claims, 23 Drawing Figs.

[52] U.S. Cl. **152/171,**
152/243
[51] Int. Cl. **B60c 27/02**
[50] Field of Search **152/167,**
170, 131, 201, 222, 180, 185, 187, 243, 244;
245/4

[56]

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ABSTRACT: A protective mail mesh and a method of making the same. A plurality of one-piece members are fabricated each consisting of at least two closed loop portions and a connecting portion connecting the same. Each of the loop portions has an opening which is so dimensioned as to permit sliding insertion therethrough of another loop portion of another member only when the loop portions of the members have a predetermined orientation with reference to one another. Each connecting portion of each of the members extends through and is at least in part slidably accommodated in a loop portion of at least one other of the plurality of members whereby all members are connected movable with respect to each other and together constitute a mail mesh particularly suitable for protecting the vehicle tires.

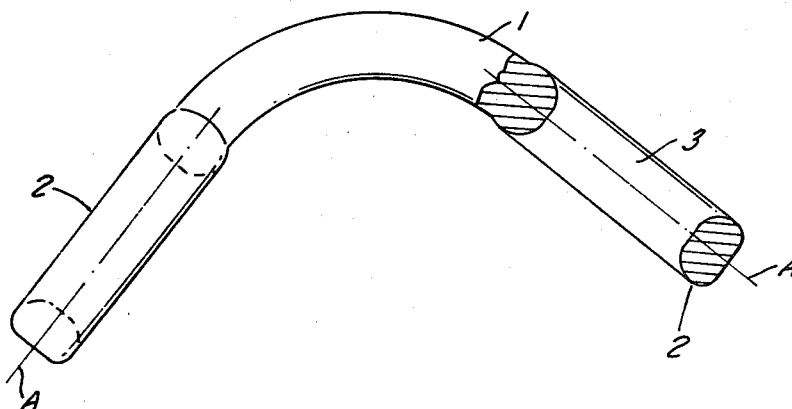


FIG. 1

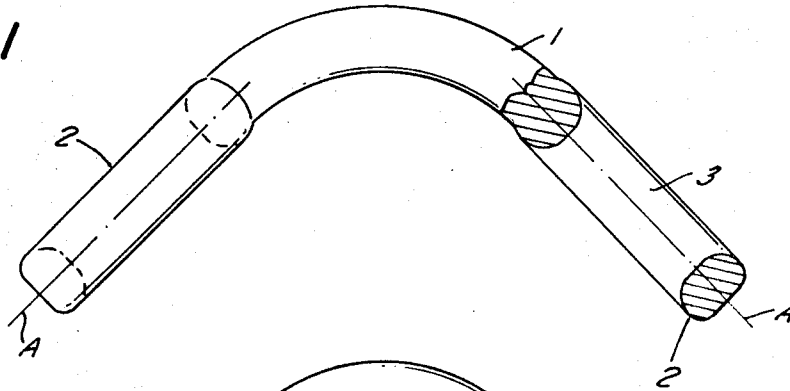


FIG. 2

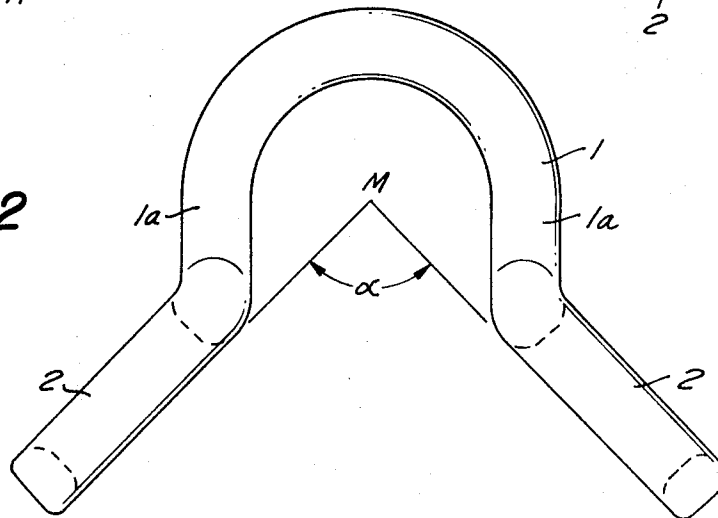
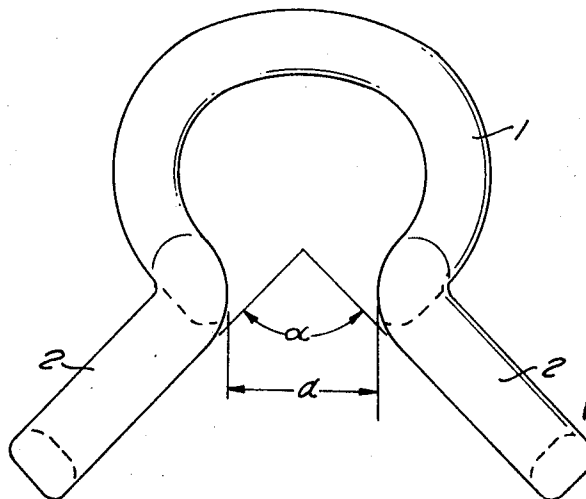


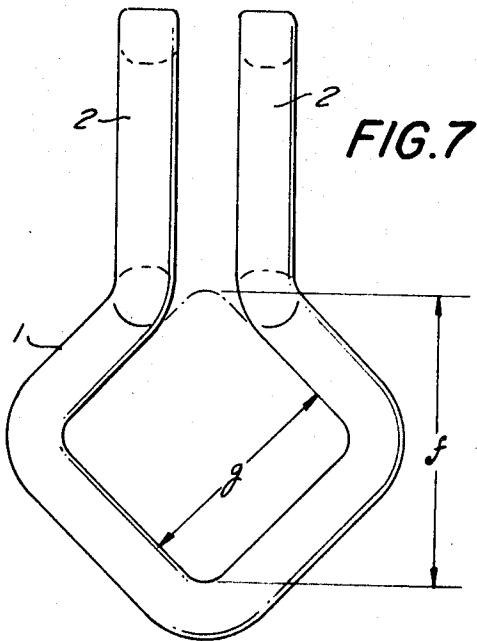
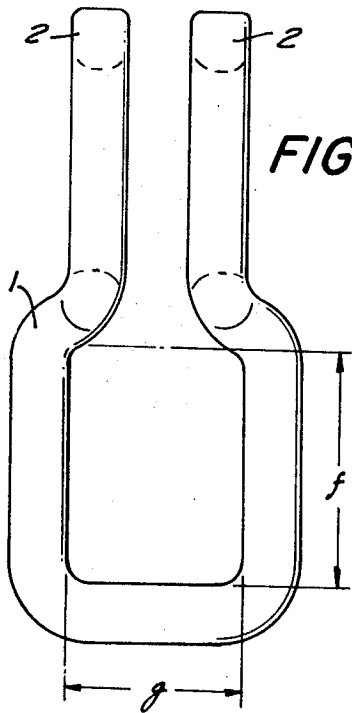
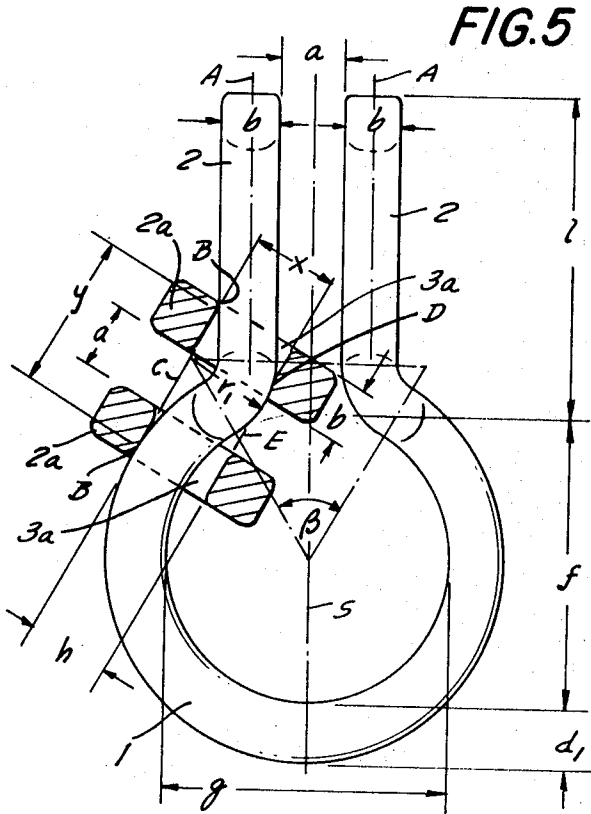
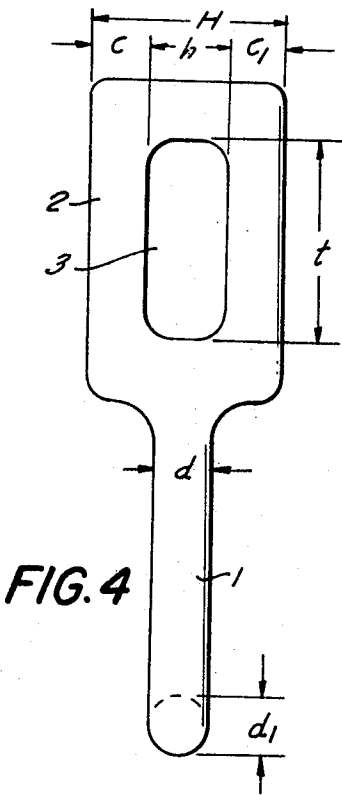
FIG. 3



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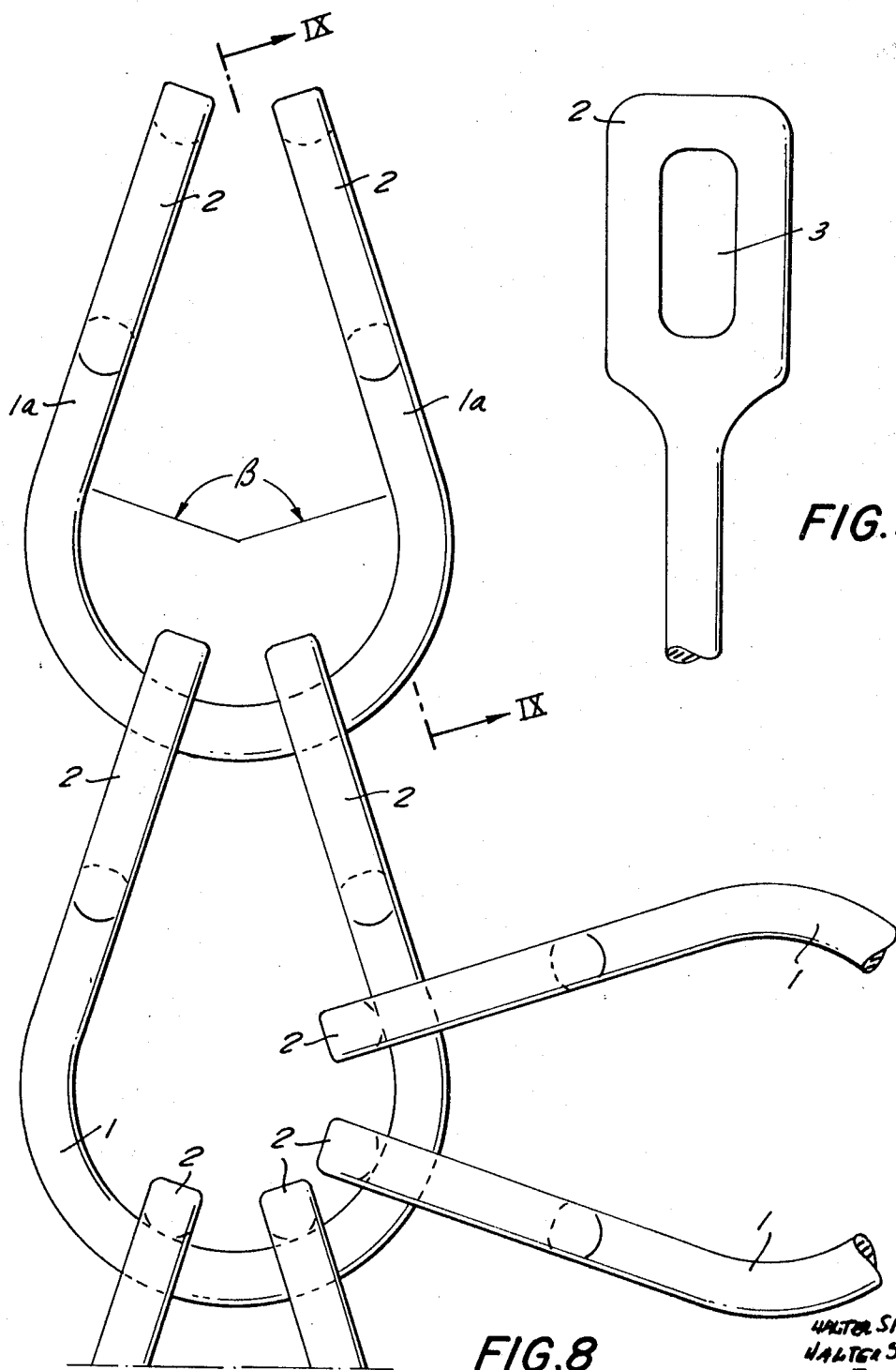


FIG. 9

FIG. 8

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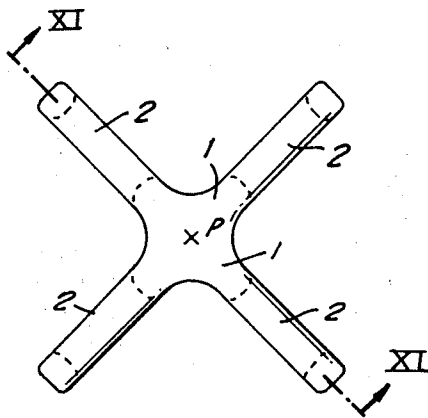


FIG. 10

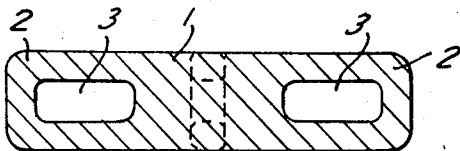
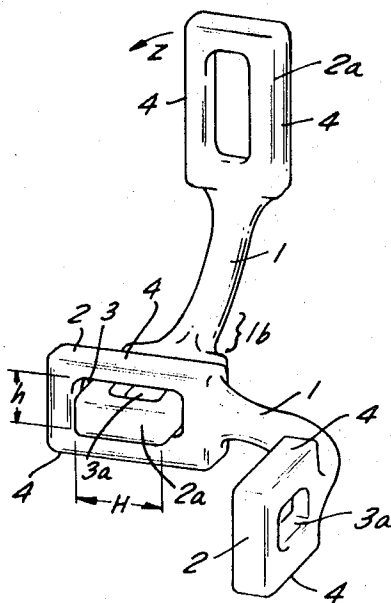


FIG. 11

FIG. 12



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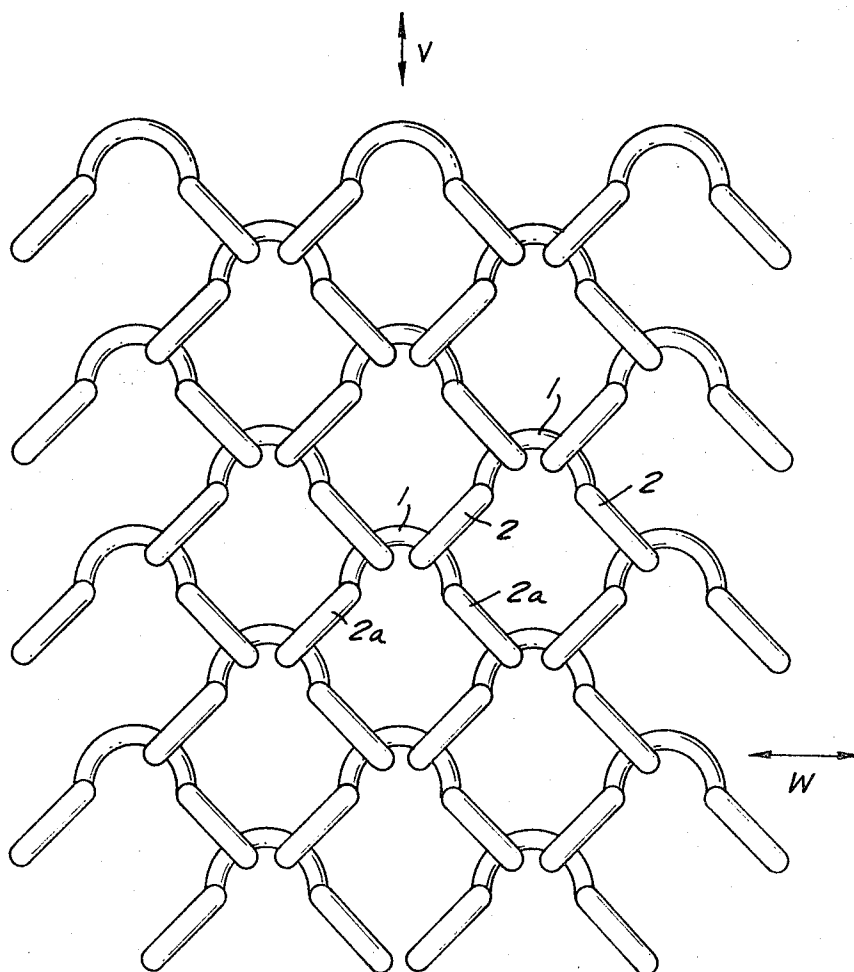


FIG. 13

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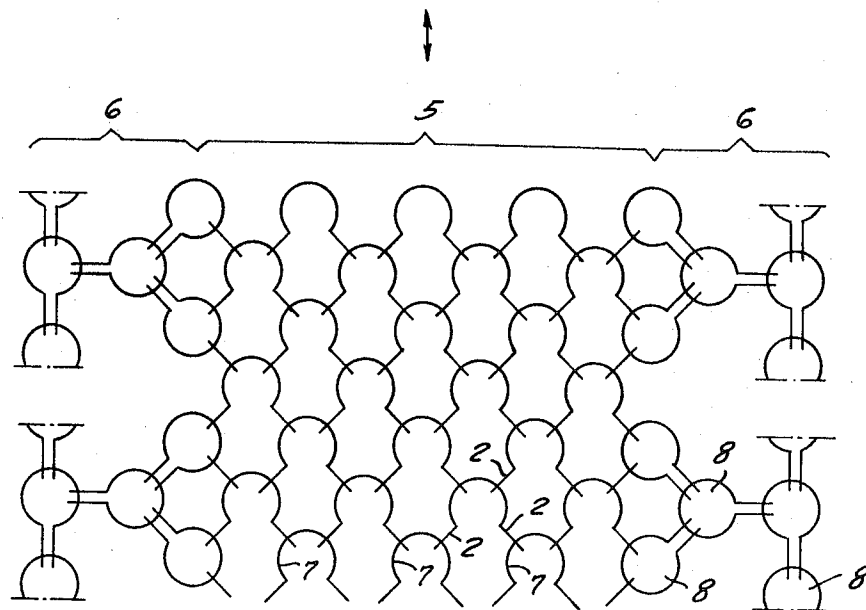


FIG. 14

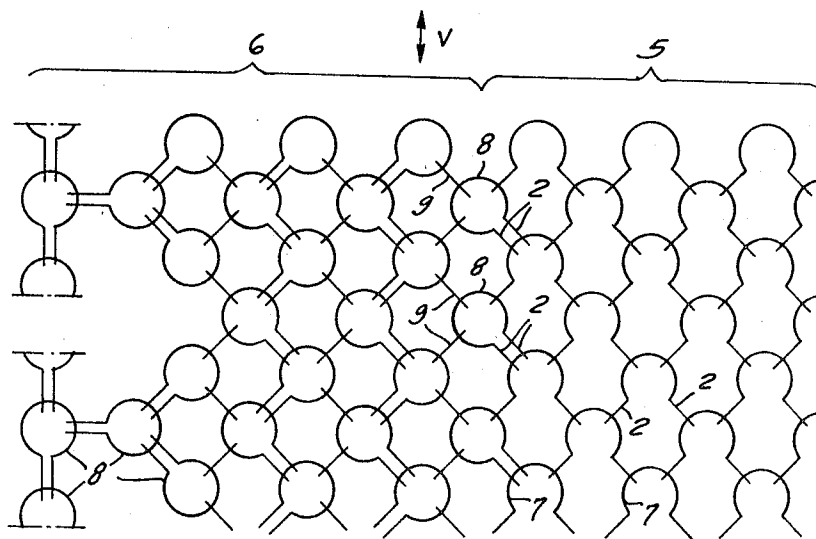


FIG. 15

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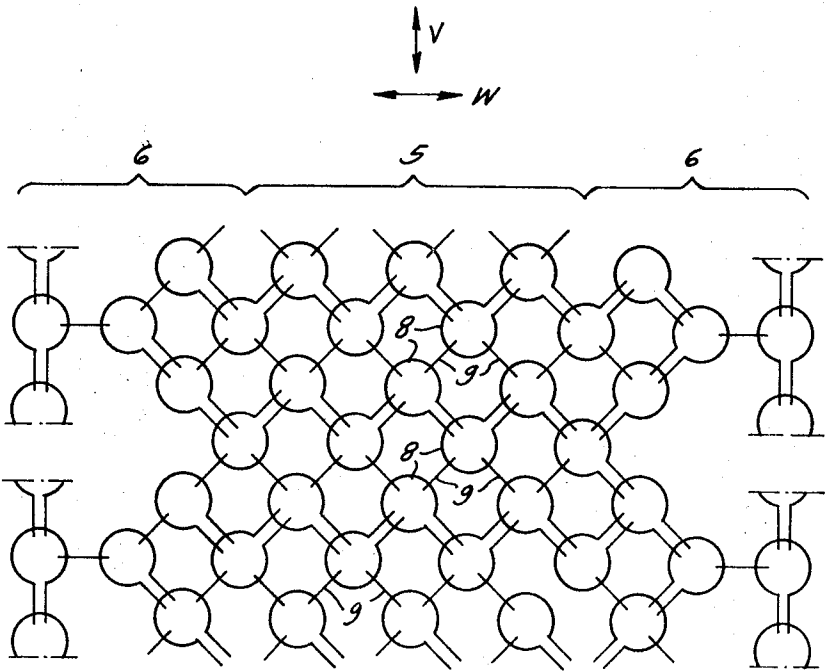


FIG. 16

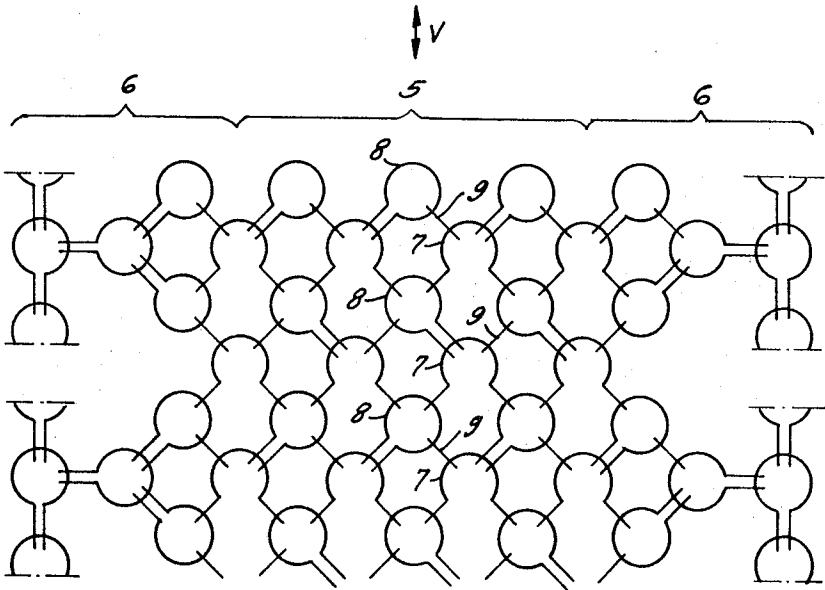


FIG. 17

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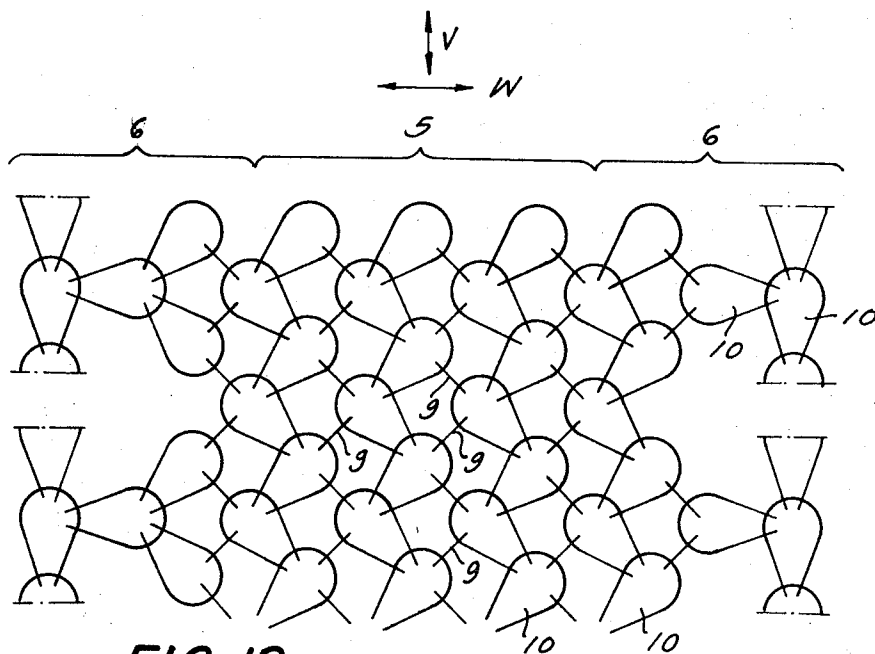


FIG. 18

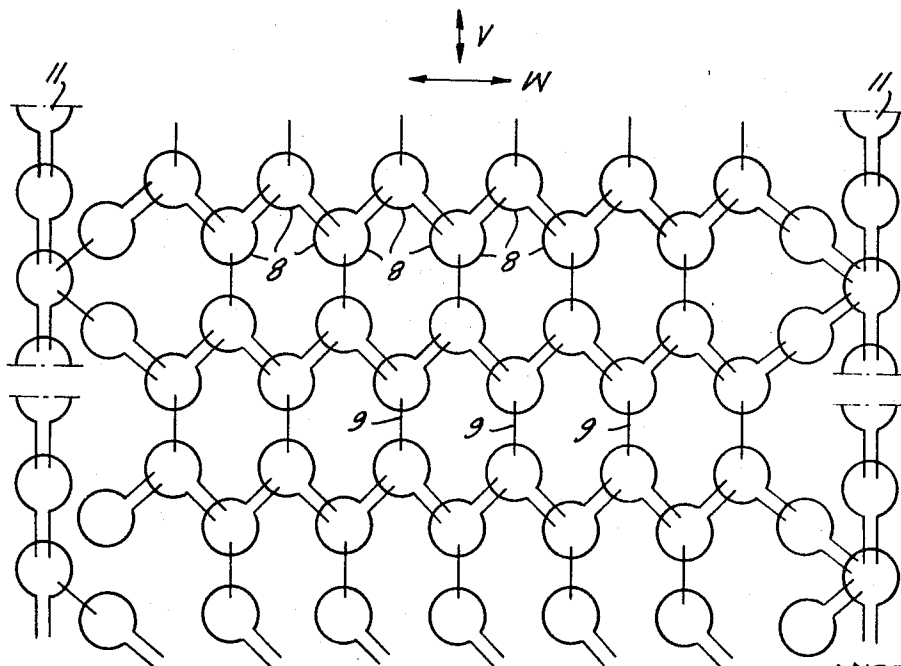


FIG. 19

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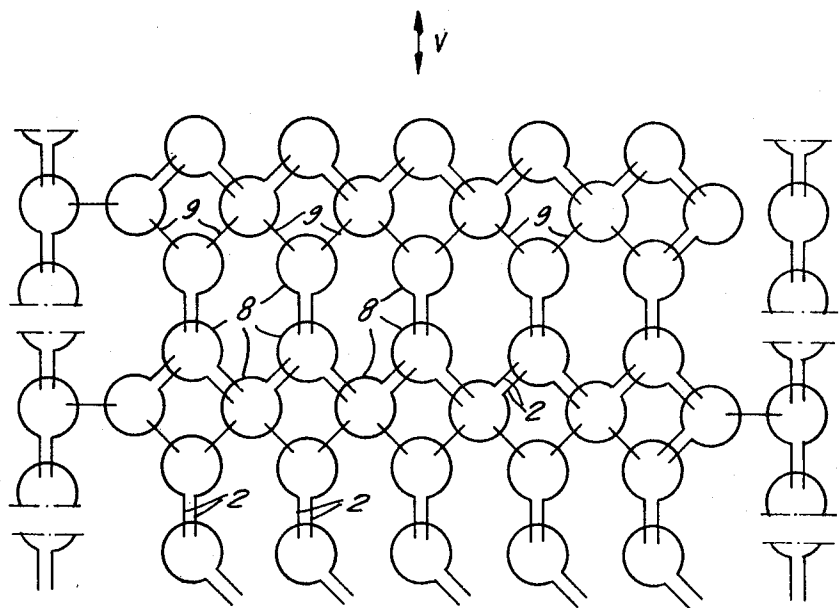


FIG. 20

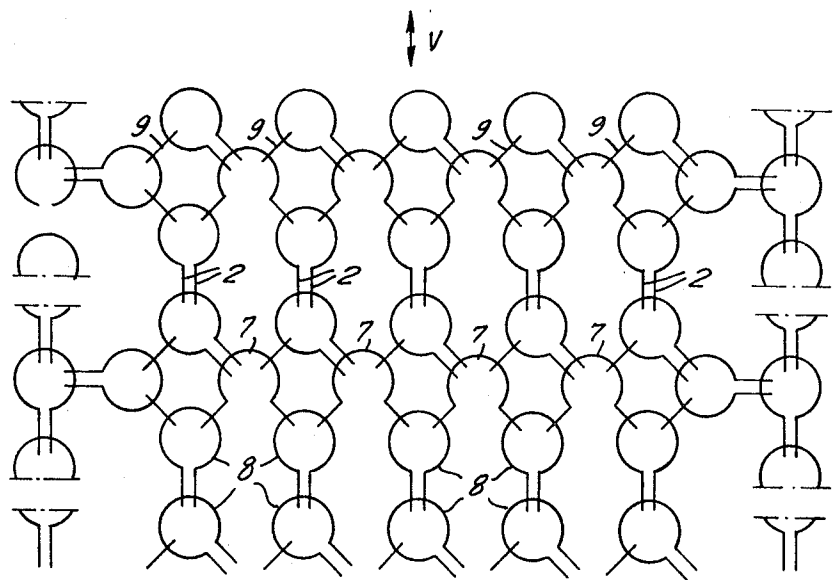


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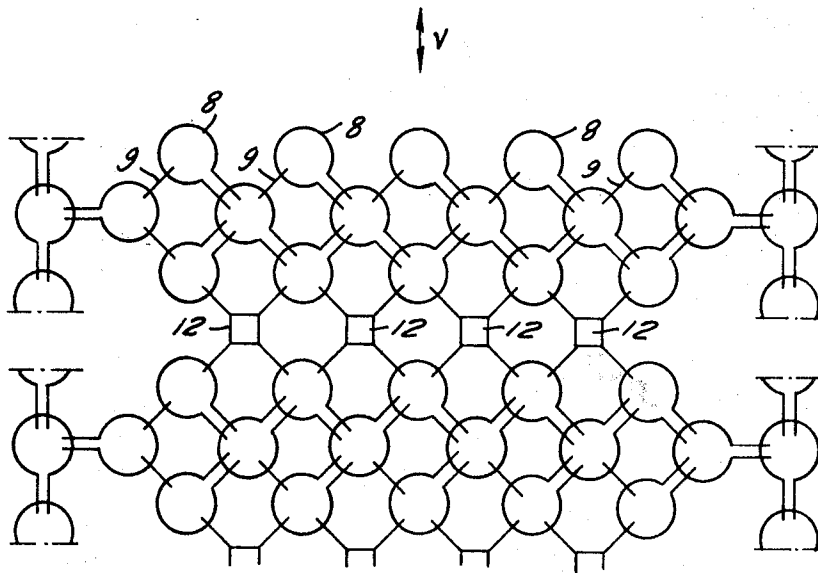


FIG. 22

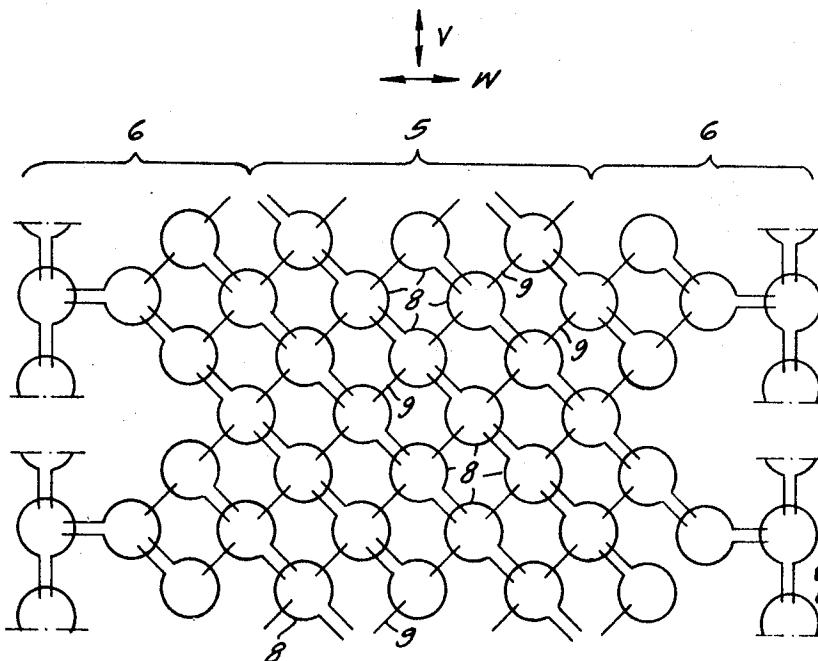


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PROTECTIVE MAIL MESH

BACKGROUND OF THE INVENTION

The present invention relates generally to mesh fabrics, and more particularly to a protective mail mesh. Still more particularly, the invention relates to a protective mail mesh for protecting vehicle tires and the like. The invention also relates to a method of making such protective mail mesh.

Heavy construction machinery and vehicles, and analogous vehicles, which are used primarily on very soft ground or on very rocky uneven ground, must be provided with protection for their vehicle tires. Evidently, if the vehicle is to be used on very rocky and uneven ground, the tires must be protected against damage; on the other hand, if the vehicle is used on very soft ground, the protection must be provided against undesired sliding and to prevent the vehicle from becoming mired. Heretofore, chains were used for this purpose, namely tire chains consisting of a plurality of chain links which are usually broken in their configuration and, subsequently being loosely connected, are closed by having their open sides welded together. Of course, it is possible to fabricate only every second link with an open side because this suffices for the necessary assembly procedure. However, even so, every second link at least must be welded on assembly of the link into a chain, and this is extremely time consuming and requires highly significant quantities of energy for welding purposes. Furthermore, welding apparatus is of course necessary for this purpose and because of the chain assembly of which the links constitute a part when they are being welded, the welding apparatus must be relatively complicated. Additionally, it is necessary that such welding operations be carried out only by skilled personnel in order to avoid improper welds and early breakage of the chains. In consequence, the manufacture of such chains is expensive and, of course, also time consuming with the result that the finished chain is quite expensive in its selling price.

Furthermore, the necessity to weld the links requires the use of such types of steel which can be readily welded. Certain types of steel which are highly resistant to wear and therefore very well suited for the purposes at hand, are thus automatically disqualified because they do not weld readily. Instead, it is necessary to make the selection of steel purely from the point of welding characteristics, forcing the selection of steels which have good welding characteristics but quite frequently have inferior resistance to wear.

A further problem with the use of steels in the manufacture of such chains is the fact that the inadequate hardness of ordinary steels makes these unsuitable for the purposes at hand. It is therefore necessary to use steels which must undergo a subsequent heat treatment. Of course, such heat treatment can be carried out only at the welding process is completed, that is after the links are assembled into a chain, because otherwise the heat treatment would be negated by heating of the chain links as they undergo welding. Accordingly, it is necessary to place the completed chain into a heating or annealing oven which, because of the very large sizes and weights of the chains involved—it being kept in mind that they are used for large-dimensioned tires on heavy vehicles—and this in turn requires correspondingly large and heavily constructed heat-treatment ovens. Ovens of this type are not, however, available as standard items and can be had only as specially manufactured items which are correspondingly expensive. On the other hand, with rare exceptions it is not possible for economical and technical reasons to use such ovens for general purposes other than the annealing of these special tire chains. Economic considerations make the purchase of such specialty ovens frequently impossible under these circumstances and the manufacturer is forced to utilize ovens which are available as standard items. However, these ovens are so limited in their capacity that it is generally not vehicle to simultaneously heat treat an entire chain for large vehicle tires. This, then, makes it necessary to assemble the chain in section which are in-

dividually heat treated and subsequently connect. However, such subsequent connection is not possible by welding because this would negate the beneficial effects of the heat treatment. It is therefore necessary in the prior art to use special relatively complicated connection links for joining the individually heat treated sections to one another. Evidently, this further increases the manufacturing and sales price of such chains and these special connecting links are frequently not as strong and resistant as the regular chain links who have such a form and dimensions that they adversely influence the ability of the tire chain to conform with the tire and/or to uneven terrain.

SUMMARY OF THE INVENTION

It is, therefore, a general object of the present invention to provide a protective mail mesh, particularly for protecting vehicle tires, which is not subject to the aforementioned disadvantages.

More particularly, it is an object of the invention to provide such a mail mesh which can be manufactured in a much more simple and less expensive manner than theretofore possible.

A still more specific object of the invention is to provide such a mail mesh which, as its name already indicates, is not of chain type as known from the prior art, but in form of a mesh fabric or mail fabric.

A concomitant object of the invention is to provide such a mail mesh which provides very good support of the tire with respect to the ground as well as lateral guidance of the tire and protection thereof against damage.

In pursuance of the above objects, and others which will become apparent hereafter, one feature of our invention resides in the provision of a protective mail mesh, particularly suitable for vehicle tires, which includes a plurality of one-piece members each of which consists of at least two closed loop portions and a connecting portion connecting the same. Each of the loop portions of each of the members is provided with an opening which is so dimensioned as to permit sliding insertion therethrough of a loop portion of another of the members only when the loop portions of the members have a predetermined orientation with reference to one another, and to slidably accommodate at least a part of the associated connecting portion of the respective other member. Each connecting portion of each of the members extends through and is at least in part slidably accommodated in a loop portion of at least one other of the plurality of members so that all of the members are connected movable with respect to each other and together constitute a mail mesh.

It is clear that with this construction the mail mesh can be assembled without resort to welding with a consequent significant reduction in the time required for the assembly and in the expenses involved. The time required for manufacturing a mail mesh according to the present invention is at most half that of the time necessary for assembling an equally dimensioned tire chain known from the prior art. This reduction in the time requirement is largely the result of the elimination of the various welding steps because the simple insertion of one loop portion through the opening of another is evidently much simpler and quicker than the welded connection heretofore necessary between individual links of tire chain according to the prior art. Furthermore, the expensive apparatus necessary heretofore for carrying out the welding process, and the energy requirements for operating such apparatus have been eliminated. In addition, a mail mesh according to the present invention can be assembled by unskilled help instead of requiring a skilled welder.

Even if, in the assembly of the mail mesh according to the present invention, individual ones of the members have been improperly connected, this is of little consequence and does not require the so constructed mail mesh to be discarded. Rather, it is a simple matter to disconnect the individual members from one another to reassemble them properly. Thus, an

error of this type can be corrected relatively quickly and without significant expenses. A further advantage will be seen in the fact that the elimination of the welding step makes it possible to use any type of steel suitable for the requirements made of a protective mail mesh of the type in question, regardless of whether the steel has good or bad welding properties because it does not have to be subjected to welding. Accordingly it is possible to use steels which weld badly or not at all but are particularly well suitable for the purposes at hand because they are highly resistant to wear and to breaking. This is evidently of great benefit as far as the increase of a lifetime of the mail mesh is concerned.

If types of steel are used which require heat treatment to obtain favorable characteristics concerning hardness and the like, such heat treatment need not be carried out after the protective mail mesh is assembled, but can be carried out on the individual members of which the mesh will later be assembled. This is possible because the thus treated individual members will not subsequently be subjected to welding which would destroy the desirable characteristics obtained by heat treatment. Of course, heat treatment of the individual members is greatly facilitated because it is possible to administer in conventional treatment ovens which are not only much less expensive than specialty ovens required heretofore, but which can also be used for other applications so that the economics of the situation are vastly improved. Of course, the previous necessity to manufacture the chains in individual sections which are heat treated and subsequently connected is eliminated in the protective mail mesh according to the present invention. As just pointed out, the individual members can be heat treated and subsequently be assembled into the mail mesh. Also, there is no need for special connecting members as heretofore, except if it should be desired to provide such special connecting members at the opposite ends of the mail mesh where the same meet when the mesh has been placed around a vehicle tire, the purpose being to provide a releasable connection to facilitate mounting and demounting of the tire. However, it is possible in accordance with the invention to provide an endless mail mesh and to thereby completely eliminate the need for special connecting members.

The novel features which are considered as characteristics for the invention are set forth in particular in the appended claims. The invention itself, however, both as to its construction and its method of operation, together with additional objects and advantages thereof, will be best understood from the following description of specific embodiments when read in connection with the accompanying drawing.

BRIEF DESCRIPTION OF THE DRAWING

FIGS. 1-3 are each plan views of three different one-piece members according to the present invention;

FIGS. 4 and 5 illustrate another one-piece members according to the present invention in a side view and a plan view, respectively;

FIGS. 6 and 7 are two plan views of two further one-piece members according to the present invention;

FIG. 8 is a plan view showing several horseshoe-shaped members according to the present invention connected to one another;

FIG. 9 is a section taken on the line IX-IX of FIG. 8;

FIG. 10 is a plan view illustrating still another member according to the present invention;

FIG. 11 is a section taken on the line XI-XI of FIG. 10;

FIG. 12 is a perspective view illustrating two of the members shown in FIG. 1 in the process of being assembled with one another;

FIG. 13 is a section of a protective mail mesh assembled from members of the type shown in FIG. 1, in a plan view; and

FIGS. 14-23 are diagrammatic fractional plan views similar to FIG. 13 but illustrating sections of protective mail mesh fabrics assembled from various different members and in various different arrangements.

DESCRIPTION OF THE PREFERRED EMBODIMENTS

Discussing firstly FIG. 1 it will be seen that we have illustrated therein a single one-piece member for making a protective mail mesh according to the present invention. FIG. 1 illustrates one possible embodiment wherein the member consists of a connecting portion 1 and two closed loop portions 2 of one-piece with the connecting portion 1. The loop portions 2 are each provided with an opening 3 as clearly shown at the right-hand side of FIG. 1 where the loop portion 2 is shown in longitudinal section. In the embodiment of FIG. 1 the connecting portion 1 is arcuately curved in form of a quarter circle and the general claims A extending through the loop portions 2 normal to the plane of the drawing are substantially tangential to the arcuately curved connecting portion 1.

The member illustrated in FIG. 2 is quite similar to the one shown in FIG. 1 except that here the connecting portion 1 is configured in substantially semicircular form and provided with two straight extensions 1a which extend substantially tangential to the connecting portion 1. Also, in contrast to the embodiment of FIG. 1, the loop portions 2 do not extend tangential to the curvature of the connecting portion 1 but rather include an angle α of substantially 90° with one another. The portions 1a are so arranged that an extension of the inner surfaces of the loop portions 1 will intersect each other and the center of curvature M of the connecting portion 1. This has the advantage that a mail mesh assembled from the members shown in FIG. 2 will be particularly well able to conform itself to the curved surface of the vehicle tire as well as to unevennesses of the ground because with such construction a significant freedom of tilting in a plane normal to the plane of the drawing is guaranteed. Also, the embodiment of FIG. 2 is particularly suitable for drop forging production.

The embodiment illustrated in FIG. 3 differs from FIG. 2 in that the connecting portion 1 is of substantially oval outline but with one side—one of the longer or less curved sides of the oval—being opened as shown. Here, also, the loop portions 2 include with one another an angle α of approximately 90° .

The member illustrated in FIGS. 4 and 5 differs from the embodiments in FIGS. 1-3 in that the connecting portion 1 is of substantially circular outline as particularly visible in FIG. 5. However, the circle outlined by the connecting portion 1 is not closed; rather, it is open as indicated by the substantially 65° and β . In this embodiment the loop portions 2 are transversely spaced and extend in parallelism with one another, the spacing being identified with a . In FIG. 1 we have illustrated loop portions 2a of another member which is assumed to be requiring connection with the member of FIG. 5. The loop portions 2a are illustrated in section and the time at which the section is taken is when they are being slidably inserted over one of the loop portions 2 onto the connection portion 1. It will be seen that the loop portions 2a and their openings 3a are of the same dimensions as corresponding elements of the members shown in FIGS. 4 and 5. In FIG. 4 the width of the opening 3 is identified with h and the length with t . The same reference designations can be found in FIG. 5, and it will be seen that when the loop portions 2a are to be connected with the member shown in FIG. 5, the loop portions 2a will contact the outer surface of the member of FIG. 5 at the contact points B. To assure that the loop portions 2a can be connected in this manner with the member shown in FIG. 5, it is necessary that the width h of the loop portions 2 as measured in their respective general plane A be in the openings 3 and be at least identical with the width of the larger than the thickness of b of the loop portions measured in the direction normal thereto. It is further necessary that the length t of the openings 3 be at least identical to and preferably larger than the total width H of each loop portion measured in the same plane. Further, the width h of the openings 3 must be at least the same as and preferably larger than the thickness d of the connecting portion 1 measured in this direction, as shown in FIG. 4. These requirements must be met in all embodiments shown in the drawing to make it possible to insert the loop portions of one member over those or through those of another. Furthermore,

in the embodiments of FIGS. 3 and 5 it is necessary that the smallest distance between the adjacent loop portions 2 of one member, identified with a , be at least before and during assembly of the protective mail mesh greater than the distance c and c_1 of the arms laterally bounding the loop portions and measured in the general plane A of the loop portions, because otherwise it is not possible to put the loop portions 2 through the openings $3a$ in the loop portions $2a$ as shown in FIG. 5.

Finally, it is also necessary to assure that time loop portions $2a$ can be moved the region where the loop portions 2 merge into the connecting portion 1. For this it is necessary to assure that in addition to the previous requirements the width h of the respective loop portions $2a$ mesh in their general plane A of the openings $3a$ be at least equal to but preferably larger than the distance x corresponding to the distance between the connecting line C of the two contact point B of the two adjacent loop portions $2a$ of the same member with the other member and a line E extending parallel thereto through the outermost contact point D of the radius r_1 of one of the loop portions $2a$, with the radius r_1 constituting the changeover from the inner surface of the loop portion 2 to the inner surface of the connecting portion 1, measured at the time when the contact points D on passing-through of a loop portion 2 or a connecting portion 1 are spaced farthest from one another, that is when the dimension y in FIG. 5 has reached its largest value. If these requirements are met, then the individual members can be slidably connected in the described manner without any difficulties and be united into a protective mail mesh according to the present invention.

A further preferred dimensional relationship is in having the respective length l of the opening 3 of the loop portions be at least double and preferably still larger than the thickness d_1 of the connecting portion 1, as indicated in FIGS. 4 and 5. Furthermore, the member illustrated in FIGS. 4 and 5 is so configured that the length l of each loop portion 2 projecting to the symmetry plane S extending substantially normal to the plane of the connecting portion 1 is for each loop portion 2 has with respect to the length f projected to the same plane S of the aperture substantially surrounded by the associated connecting portion 1 a ratio of approximately 1:0.8 to 1:2.0. Further, FIG. 5 still shows the dimension g which indicates the width as seen substantially normal to the symmetry plane S of the aperture surrounded by the connecting portion 1. In the circular configuration shown in FIGS. 4 and 5, this dimension corresponds to the dimension f . However, it should be at least equal to and preferably larger than the sum of the distance a and twice the thickness b .

The embodiments of the members illustrated in FIGS. 6 and 7 correspond largely to the one shown in FIGS. 4 and 5 with the difference that the configuration of the connecting portion 1 is not circular but rather, in FIG. 6, substantially rectangular and in FIG. 7 substantially quadratic. In FIG. 6 the connecting portion 1 surrounds a rectangle which is substantially closed except for one of its shorter sides, whereas in FIG. 7 the connecting portion 1 surrounds a square having one open corner. The dimensions are the same as outlined with respect to FIGS. 4 and 5, and these dimensions are valid for the following embodiments. However, the dimensions g and f are somewhat different and therefore identified in FIGS. 6 and 7 respectively.

FIGS. 8 and 9 show a further embodiment of a member for use in a protective mail mesh according to the present invention. This embodiment chose the member to be of substantially horseshoe-shaped configuration and the correspondingly curved connecting portion $1a$ surrounds an aperture which is open between the arms of an angle β of approximately 135° . Straight extension portions $1a$ are provided on the connecting portion 1 and extend tangentially to the curvature of the connecting portion 1. Fig. 9 clearly shows that in this embodiment, as in all the others, the outline of the loop portions 2 is substantially rectangular with rounded corners. However, the loop portions 2 may, it should be emphasized, also have a different configuration, for instance a substantially oval outline.

In FIGS. 10 and 11 we have illustrated yet a further member according to the present invention which in contrast to the preceding embodiments has four loop portions 2. These correspond to the loop portions 2 which have been previously discussed but the connecting portion 1 here consists of parts which cross each other at the point P which constitutes the center of the illustrated member. Again, the member shown in FIGS. 10 and 11 is of one-piece construction.

FIG. 12 illustrates by way of example how two of the members of FIG. 1 are connected with one another. Here, one loop portion $2a$ of one member is inserted through the opening 3 of a loop portion 2 of the other member and it is clear that this is possible only if the respective loop portions have a predetermined orientation relative to one another. Once the loop portions have so been connected and the end portion $1b$ of the connecting portion 1 is located within the confines of the opening 3 of the loop portion 2, then the opposite loop portion $2a$ is tilted in the direction of the arrow z so that the dimension H of the just inserted loop portion $2a$ is now considerably larger than the dimension h of the opening 3 for which it has been inserted. It is clear that now on undesired disconnection of the two members is no longer possible particularly because, when an entire protective mail mesh is assembled, the two members illustrated in FIG. 12 will be held still further in their respective positions by connection with the additional members which surround them and are not illustrated in FIG. 12. The contact surfaces 4 identified in FIG. 12 contact and support the vehicle tire with respect to the ground whereas, if the ground is even partially level, the connecting portions 1 will contact neither the ground or the vehicle tire.

From the embodiments illustrated it will be clear that it is advantageous with the general planes of the respective loop portions of each member extend inclined with respect to one another at an acute angle or on obtuse angle and include with one another an angle of between 30° and 150° , preferably of substantially 90° . However, as also shown, the general planes of the loop portions may also be located in parallelism with one another. These general planes advantageously extend substantially normal to the plane in which the connecting portion one of the respective member is located. However, this is not absolutely necessary and the general planes of the loop portions may also be inclined at an angle of substantially 45° with respect to the plane in which the connecting portion is located. Which of these various possible embodiments is utilized depends upon the type of terrain for which the protective mail mesh is to be employed as well as the type of vehicle on which it is to be used, the work to be performed thereby, and similar considerations.

It is particularly advantageous from a point of view of manufacture if all loop portions of each type of member have identical form and dimensions. Furthermore, this of course eliminates any need for special handling and checking during assembly.

Generally speaking it is advantageous if the connecting portions are curved along one or several relatively large radii. Such curvature may be in form of quarter surface, have surface or the like, as already shown, and the various other possibilities have been suggested by way of example in the preceding embodiments.

The embodiment illustrated in FIGS. 8 and 9 is preferred from a point of view of manufacture, particularly if the thus configured members are made by drop forging. Furthermore, this type of member when assembled in a protective mail mesh is particularly advantageous as will be discussed.

With respect to the embodiments of FIGS. 10 and 11, we wish to point out that this is especially advantageous for the assembly of the protective mail mesh intended for tires of particularly large dimensions. The necessarily larger dimensioning of the members of FIGS. 10 and 11 versus the type of members having only a one-part connecting portion 1, makes it possible to reduce the number of individual members required for assembly for a protective mail mesh and this in turn reduces the time required for the assembly and the expenses for the manufacture of the mesh.

Usually, the openings in the loop portions will, when the assembled protective mail mesh is placed onto a tire, extend substantially in parallelism with the tire surface. However, it is also possible to have the openings extend at an acute angle of up to approximately 45° to the tire surface, a construction which is particularly advantageous for tires with relatively small outer diameters. It is also advantageous, regardless of which of the various types of members are used, if all corners and edges on the connecting portions and the loop portions are rounded along relatively large radii. This avoids clamping and binding of the individual members with respect to one another during use and thus reduces a source of increased wear and possibly deformations or breakage. Furthermore, such a configuration of course facilitates the connection of the individual members.

Various different types of steels are suitable for making the members according to the present invention. Thus, drop-forged steel is suitable, as is annealed alloy steel, alloyed or unalloyed tool steel and austenitic hard manganese steel. It will be clear that the steels which have been listed here are primarily those which have been given wear-resistant characteristics by heat treatment. It will also be clear, however, that other types of steel are suitable for the purposes at hand as has been pointed out earlier.

A novel protective mail mesh according to the present invention—including both the section covering the tread face of the vehicle tire and the sections covering the side faces thereof—is assembled without the use of welded parts at least predominantly, and advantageously by far predominantly of one-piece fenders of the type outlined before and assembled in the manner set forth here. It is advantageous if the section covering the tread face and/or the sections covering the side faces of the vehicle tire consist exclusively of one-piece members according to the present invention, except for connecting members which may be utilized at the opposite ends to join the same. These sections may predominantly be constructed from identical one-piece members which greatly reduces the expense involved in the manufacturing and stocking of such members. However, it is also possible to have for instance the section covering the tread face of the vehicle tire consist predominantly of a plurality of one-piece members which are identical with one another but which are different from those from which the sections covering the side faces of the vehicle tire are assembled. In this case one obtains different characteristics for the section covering the tread face and the sections covering the side faces. Also, of course, it is possible for instance to construct the section covering the tread face at least predominantly of identical one-piece members and to construct the sections covering the side faces of two different types of members which are alternately connected with one another. Again, the section covering the tread face may be assembled with a plurality of different members whereas the sections covering the side faces may at least be predominantly assembled from identical members. Other possibilities will of course offer themselves to those skilled in the art and are intended to be included in this recitation.

Regardless of the particular construction utilized, however, it will be appreciated that the large number and varieties of individual one-piece members as well as possibilities for assembling them in different combinations provides for the possibility of assembling a protective mail mesh of great versatility and diversity, and which can be tailored exactly for the given operating requirements, ground conditions, tire dimensions and the like to thereby obtain optimum characteristics.

Generally it is advantageous if the loop portions of the individual members, which serve as contact and supporting elements, all extend at an acute angle with respect to the direction of forward rotation of the vehicle tire. This not only provides high traction as a result of excellent contact with the ground, but also good lateral guidance of the tire. If the lateral guidance of the tire, or the ground contact and consequent traction is particularly high, then the loop portions can all extend either in or transversely to the direction of rotation of the vehicle tire. Of course, a combination of these arrangements is also possible.

Coming now to FIG. 13, it will be seen that we have illustrated here a section of a protective mail mesh assembled exclusively from members of the type illustrated in FIG. 2. Clearly, the individual members cannot accidentally become disconnected. In this embodiment the mail mesh may be so mounted on the tire that the direction of rotation of the tire is indicated with the arrow V, where it may be so mounted that the direction of rotation of the tire as indicated by the arrow W. In either case, the loop portions 2 which constitutes the supporting rod abutting portions will always extend at an angle of approximately 45° with respect to the direction of rotation of the tire.

FIG. 14 is somewhat reminiscent of FIG. 13 although it is much more diagrammatic. Here, the direction of rotation of the tire to which the mail mesh of FIG. 14 is to be applied, is identified with the arrow V. Reference numeral 5 generally identifies the section of the protective mail mesh which contacts the tread face of the tire and reference numeral 6 identifies the sections which contact the side faces of the tire. The section 5 is illustrated as consisting of individual members of the type shown in FIG. 3 and identified with reference numeral 7, whereas the sections 6 are shown to be assembled from individual members 8 of the type shown in FIGS. 4 and 5.

The individual members 7 are so configured and connected with one another that each member 7 abuts at four points against the ground as well as against the tire. This assured that a tilting of the loop portions 2 on which the tire is supported is completely impossible. Accordingly, the exceedingly high wear which would result if tilting of the loop portions 2 were to be permitted, is avoided with this construction. Furthermore, the supporting loop portions 2 always extend under an angle of approximately 45° to the direction V in which the tire rotates so that the lateral guidance for the tire is good as well as the traction which is provided. As shown in FIG. 14, the individual members 8 of which the sections 6 are assembled can be readily and without any difficulties connected with the members 7 as well as with other individual members. They permit a larger movement in planes which extend approximately normal to the plane of the drawing and as a result the section 6 can conform readily to the outer configuration of the tire in the region of the tire shoulder.

The embodiment of FIG. 15 is another diagrammatic illustration reminiscent of that in FIG. 14. It illustrates the left-hand side of a section 5 of a protection mail mesh extending across the tread surface of the tire, and a section 6 which contacts one lateral tire surface. The nonillustrated half of the section 5 and the nonillustrated second section 6 are mirror symmetrical with respect to what has been illustrated and therefore would not contribute anything to an understanding of the invention if illustrated.

In the embodiment of FIG. 15 again the section 5 consists of a plurality of individual members 7 corresponding to those shown in FIG. 3 in detail. However, in the region of the tire shoulder there begins the relatively wide dissection 6 which here consists of a plurality of individual members 8 of the type shown in FIGS. 4 and 5 which in part are connected to one another and in part are connected by closed chain links 9 of conventional construction. These conventional chain links 9, which need not be further illustrated because they are simply closed to elongated loops well known to anyone conversant with the construction of chains, provide for particularly great flexibility of the mail mesh in the regions where they are utilized. In fact, their use makes it possible to lift up the section 6 in toto substantially normal to the plane of the drawing when the section 5 is lying in a flat position.

It will be seen that the first row of conventional chain links 9, located closer to the section 5, is so arranged that it is located precisely in the region of the tire shoulder by substantially normal lifting of the section 6 with respect to the section 5 is necessary. Thus, the mail mesh shown in FIG. 15 is particularly advantageous because of its ready conformance with the exterior configuration of the vehicle tire. A number of individual members 8 is located between the first row of known chain links 9 and the individual members 7 of the section 5,

the context of the mail mesh. In FIG. 16 the loop portions of two adjacent individual members 8 are always turned through 90° with reference to one another so that the individual members 8 in FIG. 16 as seen from left to right constitute zigzag strands which extend transversely to the direction of advancement v and with the individual strands being connected by conventional closed chain links 9. By contrast, and the embodiment of FIG. 23, the loop portions of the individual members 8 are all arranged in parallelism with one another so that the individual members 8 constitute individual strands inclined to the direction of advancement v or w and which strands are again connected with the known chain links 9. The embodiment according to FIG. 23 makes it possible for the loop portions 2 of the individual members 8 to perform more pronounced tilting movements on the connecting portions 1 of the adjacent individual members 8 than is possible in the embodiment of FIG. 16. As a consequence we obtain the significant advantage that the embodiment of FIG. 23 can conform still more intimately to the tire than was the case in FIG. 16 which is of particular advantage in tires which undergo strong deformations during use.

It will be appreciated that many other combinations and arrangements are possible, and that many other configurations of the individual members are conceivable. Thus, the mail mesh which can be constructed for the individual requirement can always be assembled with a view towards maximum utility and maximum performance characteristic, maximum protection for the vehicle tire and maximum guidance of the tire with maximum traction transmission.

The method of assembling or fabricating a protective mail mesh according to the present invention eliminates the need for any welding by manufacturing the mail mesh from individual members of the type herein disclosed which are assembled in the manner discussed earlier without the need for any welding. Such a mail mesh may be predominantly constructed and assembled from such one-piece members, thereby avoiding the disadvantages known from the prior art, and obtaining the advantages set forth. The individual members are advantageously made by drop forging that can also be constructed in other ways, for instance by casting or by forming suitable blanks, such as bar stock, and subsequently welding together the properly bent portions where this is necessary. It is particularly advantageous to form the individual members completely prior to assembly, that is to have them undergo all necessary processes including necessary heat treatment because this greatly facilitates the assembly of the mail mesh and avoids the need for investments of working capital in special heat treatment ovens of the type required for heat treating the large, bulky and heavy completed mail mesh. Furthermore, according to the present invention, protective mail mesh of the type here disclosed can be quickly assembled to order because of the elimination of welding steps and of subsequent heat treatment. It is therefore for all practical purposes no longer necessary to have completed mail mesh in stock, and rather such mail mesh can be manufactured to order as the individual order is received.

We still wish to emphasize that in certain embodiments of the individual members according to the present invention it may be advantageous to subject the members to bending subsequent to their assembly into the protective mail mesh, such that the aperture which is partially surrounded by the curved or otherwise bent connection portion will no longer be opened, but will instead be completely closed. In other words, the connecting portion should constitute a circumferentially complete outline of a circle, rectangle or whatever configuration. Depending upon the size of the individual members so to be treated this is sometimes not possible without localized heating of the portions of the members which have to be deformed, but this localized heating does not require placing of the members or the mail mesh into a heating treatment oven and instead is carried out locally by directing heat to the respective portions of the members which undergo such deformation.

It will be understood that each of the elements described above, or two or more together, may also find a useful application in other types of constructions differing from the types described above.

While the invention has been illustrated and described as embodied in a protective mail mesh which is particularly suitable for vehicle tires, it is not intended to be limited to the details shown, since various modifications and structural changes may be made without departing in any way from the spirit of the present invention.

What is claimed as new and desired to be protected by Letters Patent is set forth in the appended

1. A protective mail mesh of exteriorly surrounding vehicle tires, including a first section surrounding a tire tread face and a pair of second sections at opposite lateral sides of said first section and each surrounding a tire side face, each of said sections comprising a plurality of rigid one-piece steel members each consisting of a connecting portion laying in a first plane and of at least two flat closed loop portions connected by said connecting portion and lying in second planes normal to said first plane, each of said loop portions of each of said members being provided with an opening so dimensioned as to permit only sliding insertion therethrough of a loop portion of another of said members only when the loop portions of said members have a predetermined orientation with reference to one another, and to slidably and turnably accommodate at least a part of the associated connecting portion of said other member, and all connecting portions of all of said members lying in the same plane and each extending through and being at least in part slidably and turnably accommodated in a loop portion of at least one other of said plurality of members, whereby all of said members are connected movable with respect to each other and together constitute a mail mesh with all of said connecting portions extending in said same plane and all of said flat loop portions extending normal to said same plane.

2. A protective mesh as defined in claim 1, wherein said second planes of said loop portions are the respective general planes thereof; and wherein said general planes of the loop portions of each of said members are inclined with reference to one another.

3. A protective mesh as defined in claim 1, wherein said general planes are inclined with reference to one another at an acute angle.

4. A protective mesh as defined in claim 2, wherein said general planes are inclined with reference to one another at an obtuse angle.

5. A protective mesh as defined in claim 2, wherein said general planes are inclined with reference to one another at an angle between substantially 30° and 150°.

6. A protective mesh as defined in claim 5, wherein said angle is on the order of 90°.

7. A protective mesh as defined in claim 1, wherein said second planes are the general planes of said loop portions, and wherein said general planes of the loop portions of each of said members extend transversely spaced but in substantial parallelism with one another.

8. A protective mesh as defined in claim 1, wherein said at least two loop portions of each member are of identical outline and dimensions.

9. A protective mesh as defined in claim 1, wherein said connecting portion is arcuately curved.

10. A protective mesh as defined in claim 9, wherein said connecting portion has at least one radius of curvature.

11. A protective mesh as defined in claim 9, wherein said connecting portion is of part-circular arcuately curved outline.

12. A protective mesh as defined in claim 9, wherein said connecting portion has the outline of a partially complete oval having two longer sides one of which is open.

13. A protective mesh as defined in claim 9, wherein said connecting portion has the outline of a partially complete circle having an open segment which includes an angle of between substantially 20° and 80°.

and these members 8 correspond to the ones illustrated in FIGS. 4 and 5. They cannot tilt normally to the plane of the drawing because they are held by their loop portions 2 which are clamped between the tire tread face and the ground so that their connecting portion 1 extends substantially parallel to the ground and the tire tread face. A tilting is possible only in the region of the known chain links line but can in this region take place as much as required.

This construction has the advantage that the section 5 cannot move laterally so that the individual members 7 will always remain in the region of the tire tread face and axial shifting of the mail mesh is not possible with respect to the tire. This evidently results in excellent lateral guidance of the tire. It should be pointed out with respect to FIG. 15 that all loop portions, including the conventional chain links 9, are always arranged in a row one behind the other so that these rows extend approximately under an angle of 45° inclined to the direction of rotation of the tire, a factor which is highly advantageous with respect to the lateral guidance of the tire as well as with respect to the increased traction to be obtained.

As shown in FIG. 16 the section 5 of the mail mesh which contacts the tread face of the tire can also be configured analogously to the section 6 described in FIG. 15. When the entire mail mesh is so configured this results in a particularly elastically yieldable mail mesh which can accommodate itself to all unevennesses of ground and deformations of the vehicle tire. Evidently, a mail mesh of this type is particularly advantageous for use with vehicle tires which particularly strongly undergo deformation during operation of the vehicle. It should also be pointed out that with the construction shown in FIG. 16, it is immaterial whether the direction of rotation of the tire is that indicated by the arrow V or by that indicated by the arrow W, except that in the latter case it is necessary that the outer strands be turned through 90° and be arranged at the upper and lower edges as seen in FIG. 16 and not—as illustrated—at the right and left-hand side. It should also be pointed out that generally it is desired to associate as few loop portions as possible with any one connecting portion to guarantee maximum possible freedom of movement of the connected members with respect to one another. However, this is the case only if the loop portions can have considerable freedom of movement on the associated connecting portion and this in turn is possible only if not too many loop portions are associated with any one connecting portion.

Coming now to the embodiment in FIG. 17, it will be seen that this is reminiscent of the one in FIG. 16. The difference is that in place of the individual members 8 according to FIGS. 4 and 5, there are also used individual members 7 according to FIG. 3 which partially are directly connected and partially connected through the use of the conventional chain links 9 of known construction. This embodiment also has a high degree of conformance to the ground and to the configuration of the vehicle tire but compared to the one in FIG. 16 it is of somewhat coarser mesh and thus has an improved self-cleaning effect which is particularly important when the ground on which it is to be used is soft.

The embodiment of FIG. 18 utilizes predominantly the members of the configuration illustrated in FIG. 8 and 9, here identified with reference numeral 10. The individual members 10 are particularly in the region of the section 5 in part connected with closed chain links of conventional known construction. Other than this, the embodiment of FIG. 18 corresponds substantially to the embodiment of FIG. 16 and in both cases the mail mesh obtained is of relatively fine mesh and provides a particularly large contact surface which serves to support the tread face of the tire with respect to the ground and thus reduces the specific surface pressure. This, in turn, is advantageous in reducing the tire wear and of course the fine mesh provides excellent protection against damage of the tire through sharp-edged rocks and the like. The direction of rotation of the tire with which a mail mesh of the type in FIG. 18 is used, may either be in the direction of the arrow v or in the direction of the arrow w, but in the latter case it is again neces-

sary to arrange the outer left and right strands turned through 90°, that is at the upper and lower edges in FIG. 18 instead of at the left and right-hand side as now illustrated.

FIG. 19 shows particularly coarse-mesh construction having a very strong self-cleaning effect and thus being particularly well suited for use in soft and swampy ground. It is configured of a plurality of individual members of the type shown in FIGS. 4 and 5 as well as a plurality of closed conventional chain links 9 known from the prior art. The individual members of FIGS. 4 and 5 are identified with reference numeral 8 and constitute individual zigzag-shaped strands extending in the direction W which are connected with the conventional chain links 9 with one another which are arranged one behind the other in the direction W. Again, the mesh shown in FIG. 19 can be used for a tire rotating either in the direction v or in the direction of w but in the latter case the reversal of the outermost strands must again be effected as discussed with respect to FIG. 18. It should be pointed out that the embodiment of FIG. 19 is particularly well suited if the tire rotates in the direction v because in this case the conventional chain links 9 of known construction constitute rows extending transversely to the direction of rotation w and serve to enhance the flexibility of the mail mesh in circumferential direction.

The embodiment of FIG. 20 is reminiscent of that of FIG. 19 except that the zigzag-shaped strands which again are assembled from individual members 8 of the type shown in FIGS. 4 and 5, and extending normal to the direction of rotation v are connected with closed conventional chain links 9 with additional members 8 which are arranged substantially in parallelism with one another in a row extending normal to the direction v. While this makes the mail mesh have a somewhat finer mesh construction, the mesh is still significantly coarser than in the embodiments of FIGS. 13—18 and the self-cleaning effect accordingly large. Also, because of the double loop portions 2 of the members 8 extending in the direction of rotation of the tire, which members 8 connect the individual zigzag-shaped strands with one another, this mail mesh provides particularly good lateral guidance for the tire. The strands itself, in which the loop portions 2 are inclined at an angle of approximately 45° to the direction of advancement v, act together to provide good traction. The chain links 9 which connect the strands with the individual members 8 extending in the direction of advancement v, are inclined at an angle of approximately 45° to the direction of advancement v always in rows which extend normal to the direction v. This further improves the flexibility of the mail mesh in circumferential direction although the flexibility is not as good as in the embodiment of FIG. 19.

The embodiment of FIG. 20 corresponds substantially to that of FIG. 21 except that individual members 7 of the type shown in FIG. 3 have been used which eliminates the need for the use of as many conventional chain links 9. Clearly, this in turn eliminates many possible areas of wear so that the mail mesh of FIG. 21 is particularly wear resistant. The flexibility of the mail mesh of FIG. 21 in circumferential direction is still somewhat lower than that of FIG. 20 but other than that the comments made with respect to FIG. 20 are applicable to the embodiment of FIG. 21 also.

The embodiment of FIG. 22 is constructed analogously to FIG. 20 except that the individual strands which extend transversely of the direction of advancement v are connected with individual members of the type shown in FIGS. 10 and 11. This mail mesh is of somewhat coarser mesh than the ones shown in FIGS. 13—18 but has a finer mesh than the ones shown in FIGS. 19—21. The total supporting surface which the tire is supported on the ground by the interposed mail mesh is correspondingly greater and thus the protection afforded the tire surface is correspondingly better. The mail mesh of FIG. 22 requires only very few conventional chain links 22 and is thus highly wear resistant.

The embodiment of FIG. 23 is rather similar to the embodiment of FIG. 16. It differs from the latter, however, particularly in the arrangement of the individual members 8 within

14. A protective mesh as defined in claim 9, wherein said connecting portion has the outline of a partially complete circle having an open segment which includes an angle of between substantially 120° and 160°.

15. A protective mesh as defined in claim 9, wherein said connecting portion has the outline of a partially complete circle, and wherein the general planes of the respectively associated loop portions are each plane substantially tangential to the outline of said connecting portion.

16. A protective mesh as defined in claim 9, wherein said connecting portion is of substantially horseshoe shaped outline and has opposite ends, and wherein the associated loop portions are each integral with one of said ends with their respective general plane each constituting a straight line continuation of the respective end.

17. A protective mesh as defined in claim 1, wherein said connecting portion is of substantially polygonal outline.

18. A protective mesh as defined in claim 17, wherein said connecting portion outlines a peripherally incomplete rectangle having an open side.

19. A protective mesh as defined in claim 17, wherein said connecting portion outlines a peripherally incomplete rectangle having two longer sides and two shorter sides one of which latter is open.

20. A protective mesh as defined in claim 1, said connecting portion including at least two elongated intersecting parts rigid with one another, one of said parts being provided with said two closed loop portions; and further comprising at least one additional loop portion provided on the other of said parts.

21. A protective mesh as defined in claim 20, wherein said parts cross one another centrally intermediate their respective opposite ends.

22. A protective mesh as defined in claim 1, wherein said connecting portion is of other-than-straight configuration and constitutes a circumferentially incomplete outline of an aperture, and wherein the width of said aperture measured substantially normal to the plane of symmetry of said member is at least equal to the sum of the smallest distance between said loop portions and double the thickness of the latter measured in direction normal to the general plane thereof.

23. A protective mesh as defined in claim 1, said second planes being the general planes of said loop portions and said openings each also having a general plane, and the width of said openings measured in the respective general plane at least equal to the thickness of said loop portions in direction normal to the respective general plane.

24. A protective mesh as defined in claim 1, said second planes being the general planes of said loop portions and said openings each also having a general plane, and the width of said openings measured in the respective general plane being at least equal to the thickness of said connecting portion in said general plane and in the same direction.

25. A protective mesh as defined in claim 1, said second planes being the general planes of said loop portions and said openings each also having a general plane, and the length of said openings measured in the respective general plane being at least equal to the overall length of said loop portions measured in the same direction in said general plane.

26. A protective mesh as defined in claim 1, said second planes being the general planes of said loop portions and said openings each also having a general plane, and the length of said openings measured in the respective general plane being at least double the thickness of said connecting portion measured in a plane substantially normal to said general plane.

27. A protective mesh as defined in claim 1, wherein the smallest distance between said loop portions is greater than the width of the two lateral legs bounding the loop portion measured in the second plane of the respective loop portion.

28. A protective mesh as defined in claim 27, wherein the widths of said two lateral legs are substantially identical.

29. A protective mesh as defined in claim 27, wherein the width of one of said two lateral legs is different from the width of the other lateral leg.

30. A protective mesh as defined in claim 1, wherein said connecting portion is of other-than-straight configuration and constitutes a circumferentially incomplete outline of an aperture, and wherein the length of each loop portion measured in a plane of symmetry of said member substantially normal to said second plane of the respective loop portion has a ratio of between 1:0.8 and 1:2.0 to the length of the aperture outline by said connecting portion and also measured in said plane of symmetry.

31. A protective mesh as defined in claim 30, wherein said ratio is 1:1.

32. A protective mesh as defined in claim 1, wherein said connecting portion is of other-than-straight configuration and constitutes a circumferentially incomplete outline of an aperture, and wherein the length of said aperture is at least equal to the sum of the smallest distance between said loop portions and double the thickness of the latter measured in direction normal to said second planes thereof.

33. A protective mesh as defined in claim 32, wherein said length of said aperture is between 1.5 and 2 times said sum.

34. A protective mesh as defined in claim 1, wherein said loop portions have planes of symmetry intersecting said openings and substantially normal to said second planes, and wherein said planes of symmetry coincide with the said first plane of said connecting portions.

35. A protective mesh as defined in claim 1, wherein said loop portions have planes of symmetry intersecting said openings and substantially normal to said second planes, and wherein said planes of symmetry do not coincide with said first plane of said connecting portion.

36. A protective mesh as defined in claim 35, wherein said planes of symmetry of said loop portions are inclined with reference to said first plane of said connecting portion.

37. A protective mesh as defined in claim 1, wherein said loop portions are of substantially rectangular exterior configuration and have rounded corners.

38. A protective mesh as defined in claim 1, wherein said loop portions are of substantially oval exterior configuration.

39. A protective mesh as defined in claim 1, wherein said loop portions are of substantially circular exterior configuration.

40. A protective mesh as defined in claim 1, wherein all edges and corners of said members are rounded along respective large radii.

41. A protective mesh as defined in claim 1, wherein said members consist of casehardened steel.

42. A protective mesh as defined in claim 1, wherein said members consist of alloyed annealed steel.

43. A protective mesh as defined in claim 1, wherein said members consist of tool steel.

44. A protective mesh as defined in claim 43, wherein said tool steel is alloyed.

45. A protective mesh as defined in claim 1, wherein said members consist of austenitic hard manganese steel.

46. A protective mesh as defined in claim 1, wherein said sections consist at least predominantly of identical ones of said members.

47. A protective mesh as defined in claim 1, wherein said first section consists at least predominantly of members which are different from the members in said second sections.

48. A protective mesh as defined in claim 1, said first section consisting at least predominantly of identical ones of said members, and said second sections consisting predominantly of two differently configured types of said members which are alternately connected with one another.

49. A protective mesh as defined in claim 1, said first section consisting at least predominantly of differently configured types of said members, and said second sections consisting predominantly of identical ones of said members which are alternately connected with one another.

50. A protective mesh as defined in claim 1, wherein all of said sections consist of at least two differently configured types of said members.

51. A protective mesh as defined in claim 1, said second planes being the general planes of said loop portions and said openings each also having a general plane, wherein the height of each opening measured in the longitudinal center plane of said openings is at least equal to and preferably exceeds the distance between the connecting line of two points of contact of neighboring openings of a first link with a second link engaging said openings, and a line parallel to said first line and connecting the outermost point of contact of one opening of said first link with the transition between the inside of an opening to the inner surface of the adjoining connecting portion of a second link, measured in a position in which the distance between the first mentioned contact points during insertion of an opening or connecting portion of a second link through the openings of a first link is a maximum.

52. A protective mesh as defined in claim 1, wherein said openings of said loop portions are disposed substantially parallel to the tire surface.

53. A protective mesh as defined in claim 1, wherein said openings of said loop portions are inclined at an acute angle not exceeding about 45° to the tire surface.

54. A protective mesh as defined in claim 9, wherein the tread-forming part and/or the lateral portions of the protective and/or antiskid mesh for a vehicle tire lack welded links of conventional kind and predominantly consist and preferably nearly exclusively consist of the interlinked one-piece members claimed in any one of the claims 1 to 48.

55. A protective mesh as defined in claim 54, wherein the

tread-forming part and/or the lateral portions of the mesh, with the exception of the links forming the mesh edges, consist exclusively of the interlinked one-piece members claimed in any one of claims 1 to 48.

56. A protective mesh as defined in claim 54 wherein some of the one-piece members of the same or different types constituting the tread-forming part of the mesh are interconnected by conventional closed ring-shaped chain links.

57. A protective mesh as defined in claim 54, wherein said openings of said loop portions, which serve as load-bearing elements that make contact with the tire tread and with the ground are all placed at an acute angle to the direction in which the vehicle tire travels.

58. A protective mesh as defined in claim 54, wherein said openings of said loop portions which provide the load-bearing surface that make contact with the tire and with the ground are all placed in or across the direction in which the vehicle tire travels.

59. A protective mesh as defined in claim 54, wherein some of said openings of said loop portions which serve as load-bearing elements that make contact with the tire tread and with the ground are placed at an acute angle in relation to, and others are placed in the direction of or crosswise to the direction of travel of the tire.

60. A protective mesh as defined in claim 17, wherein said connecting portion outlines a peripherally incomplete square having an open corner.

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