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SKIRTS FOR VEHICLES PROPELLED ON AIR CUSHIONS
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ABSTRACT OF THE DISCLOSURE

The present disclosure relates to skirts provided for vehicles propelled on cushions of air which comprises at least two sheets separated from each other by an elastomeric layer, each sheet being made of flexible elements separated from each other and having a direction oriented to resist specific forces and stresses, the flexible elements of said sheets being interconnected by the elastomeric layer which separates these sheets. The flexible elements of the sheets are disposed in the direction of the stresses or the components of the stresses to which the skirt is subjected.

BACKGROUND OF THE INVENTION

In ground-propelled vehicles which move as a result of being supported by cushions of air, either one or several skirts guide the air jets which emanate from the orifice of the blower and/or blowers to the surface over which the vehicle travels. The present invention relates to the design and construction of these skirts. More particularly, the present invention concerns the orientation of the flexible elements which are used to make the skirts.

Skirts for vehicles propelled on air cushions must have the following properties and concurrently must satisfy the following requirements: (a) they must be light in weight and yet adapted to withstand any exterior influences, for example, that due to tension, stress, environmental conditions, etc.; (b) they must be flexible in order to adjust without difficulty to the obstacles which may be present or which may be produced on the surface of the ground (c) the walls of the skirt should nevertheless be sufficiently strong and possess a sort of spring action so that they will return to their original position close to the surface of the ground as soon as the obstacle has been cleared by the vehicle and (d) they must substantially preserve their geometric shape for the entire period of time they are utilized.

It has been attempted to make these skirts from woven fabrics coated with an elastomer. However, irrespective of the textile material used, this method has not produced good results, particularly with skirts having the shape of a truncated cone with the smallest base positioned toward the surface of the ground. It appears that the poor results are due to the fact that the filaments of the skirt which cross each other at right angles, do not produce the same angle with respect to the direction of the stresses to which they are subjected.

SUMMARY OF THE INVENTION

An object of the present invention is to avoid the prior art disadvantages in skirts for vehicles which are displaced on cushions of air.

Another object of the present invention is to provide skirts for vehicles displaced on cushions of air which are light in weight and yet adapted to withstand exterior influences.

A further object of the present invention is to provide skirts for vehicles displaced on cushions of air which are flexible, strong, and possess a sort of spring action which returns them to their original position close to the surface of the ground after the obstacle has been traversed by the vehicle.

Other objects and further scope of applicability of the present invention will become apparent from the detailed description given hereinafter. It should be understood, however, that the detailed description and specific examples, while indicating preferred embodiments of the invention, are given by way of illustration only, since various changes and modifications within the spirit and scope of the invention will become apparent to those skilled in the art from this detailed description.

Pursuant to the present invention, it has been found that the abovementioned disadvantages may be eliminated and a much improved skirt for vehicles being displaced on cushions of air can be obtained by providing skirts which comprise an inner framework containing sheets covered on the sides thereof with an elastomeric layer or coating. The inner framework is made of flexible elements which are separated from each other and disposed in the direction of the stresses or the components of the stresses to which the skirt is subjected during operation of the vehicle, in such a manner that as many as possible of these flexible elements operate under the same conditions.

According to the present invention, the framework generally comprises at least two superimposed sheets or layers of flexible elements which are not woven and are substantially inextensible, or show little tendency therefore. The flexible elements of one sheet or layer are substantially disposed as described hereinabove, that is in the direction of some of the stresses, while the elements of the other sheet or layer are disposed in the direction of the other stresses to which the skirt is exposed.

According to a preferred embodiment of the present invention, the flexible elements constituting each layer or sheet are made from fibers having a limited amount of elongation, for example, glass fibers or rayon fibers. It has been observed that this feature makes it possible to obtain skirts which are light and flexible and virtually nondeformable, and which have a high mechanical strength while at the same time displaying the kind of spring action which is necessary to permit them to return to their original position as soon as the obstacle has been traversed by the vehicle.

BRIEF DESCRIPTION OF THE DRAWINGS

The present invention will become fully understood from the detailed description hereinbelow and the accompanying drawings which are given by way of illustration only and thus are not limiting of the present invention and wherein,

FIG. 1 illustrates a skirt as proposed by the present invention;
FIG. 2 illustrates another type of skirt according to the present invention;
FIG. 3 illustrates a further type of skirt according to the present invention;
FIG. 4 illustrates the alignment of the filaments of one layer or sheet in another skirt according to the present invention;
FIG. 5 illustrates a different alignment of the filaments according to another embodiment of the present invention;
FIGS. 6 and 7 illustrate an improved arrangement imparting to the skirts a greater degree of elasticity; and
FIG. 8 illustrates a skirt with multiple lobes enclosing or surrounding smaller skirts.
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DESCRIPTION OF THE PREFERRED EMBODIMENTS

In all of the embodiments shown, the skirts have the shape of truncated cones. However, it is to be understood that the present invention is also applicable to any other desired shape of the skirts.

FIGS. 1 and 2 are directed to embodiments wherein the skirts have the shape of straight truncated cones, whereas FIGS. 3, 4 and 5 refer to embodiments of the present invention wherein the skirts have the shape of oblique truncated cones. All of the skirts are composed of a framework covered with an elastomeric coating or layer on both sides thereof. The framework for the skirt shown in FIG. 1 comprises two superimposed sheets or layers of fibers, for example, glass fibers. The flexible elements of one sheet or layer are arranged according to the circles which are substantially parallel to the bases of the truncated cone, that is, in the direction of lines 1 of FIG. 1. The flexible element of the other sheet or layer of the framework are arranged according to the generatrices in the direction of lines 2 of FIG. 1. Taken very schematically, the flexible elements disposed in the direction of lines 1 resist the lateral stresses which are due to the pressure at the inside of the skirt, whereas those disposed in the direction of lines 2 resist the stresses directed downwardly and resulting from the surface difference between the two bases. Thus, according to the present invention, the flexible elements of the frame are oriented in the direction of the stresses to which they are commonly subjected.

If the skirt shown in FIG. 1 is made from a conventional woven fabric coated with an elastomer, the frame would be composed of the filaments of the fabric which intersect each other at right angles and which have a uniform spacing with respect to each other. This would not have been significant with respect to the sheet having flexible elements oriented as circles parallel to the bases of the truncated cone. However, the other sheet would not have flexible elements oriented according to the generatrices. Accordingly, the skirt has a lower mechanical resistance and substantial deformations are produced when the skirt is used.

A skirt such as the one shown in FIG. 1, that is, in the form of a truncated cone, can be produced in the following manner. A layer of an elastomeric material, for example, rubber or an analogous material, is applied to one sheet of the framework which forms concentric circular arcs and which when shaped as a skirt forms concentric circles substantially parallel to the bases of the truncated cone. A new layer of elastomer is applied to the coated sheet of framework and upon this layer is placed another sheet of framework according to the radii of the circular arcs of the first sheet, that is, in the finished skirt the flexible elements of the sheet are disposed according to the generatrices. A new layer of elastomer is then placed upon the latter framework and the composite is thereafter vulcanized. The skirt is then made by shaping the composite into a desired shape, for example, a truncated cone. In this regard, it should be apparent that if the flexible elements disposed according to the generatrices (line 2) were extended, they would intersect at the apex of the truncated cone. It is equally possible to shape the truncated cone first and then vulcanize the elastomer. The vulcanizing operation may be dispensed with, instead of utilizing rubber, either self-vulcanizable materials or synthetic materials are employed.

Although vulcanizing the framework has in itself the effect of limiting its elongation, it is generally desirable to use flexible elements which are as inextensible as possible. Flexible elements which are resistant to elongation and which can be readily introduced into the framework of the skirt according to the present invention include glass fibers, for example, fiberglass, metal fibers and any of the natural or synthetic materials which are also resistant to elongation. The natural fibers include those of animal or vegetable origin, for example, cotton, wool, silk, natural cellulose, etc., and the synthetic fibers of regenerated cellulose, saponified acetate fibers, nylon 6 obtained by the condensation of caprolactam, nylon 66 obtained by the condensation of hexamethylenediamine with adipic acid, “saran” obtained by the polymerization of vinyl compounds, for example, vinylidene fluoride, copolymers thereof with other unsaturated monomers, protein fibers, for example, “Vicara” obtained from corn protein, Acrilan which is a synthetic fiber made from acrylonitrile, Dacron which is a synthetic polyester fiber made from methyl terephthalate and ethylene glycol. Dyneel which is a copolymer of vinyl acetate and vinyl chloride, and other like materials. The preferred fibers are glass fibers or rayon fibers.

The elastomeric material used for coating the framework can include any of the vulcanizable materials, for example, rubber or analogous materials and also self-vulcanizable materials as well as certain synthetic materials, for example, synthetic resins which are light in weight and possess the properties of elasticity, flexibility, and sufficient strength to absorb the stresses and forces encountered in traversing the terrain. Suitable materials include polyolefins, e.g., polyethylene, polypropylene, etc., polyesters, e.g., polyethylene terephthalate, etc., polyvinyl materials, e.g., polyvinyl chloride, polyvinyl acetate, etc., acrylate resins, e.g., polymethylmethacrylate, polyurethane resins, e.g., phenol formaldehyde resins, urea formaldehyde resins, etc., polyurethane resins, and copolymers of these materials with one another or with ethylenically unsaturated monomers, and similar type polymers. The flexible elements of the present invention may be in the form of filaments, strands, cables, bands, etc. As has been indicated hereinabove, it is advantageous to use glass filaments with a slight torsion or rayon having a slight elongation in conjunction with the elastomeric material in forming the skirts of the present invention.

The framework of the skirt illustrated in FIG. 2 is similar to that shown in FIG. 1. However, the skirt according to FIG. 2 is made by placing a layer of elastomer, for example, rubber, upon a mold and winding thereon a continuous filament or band which, being positioned in the direction of line 3, constitutes in the framework the sheet or nap which resists the tension. It will be noted that in this construction, the flexible elements of this sheet or nap of the framework do not form true circles parallel to the bases. However, the angle which they form with the bases is sufficiently slight that they operate under the same conditions as the flexible elements of the skirt of FIG. 1 positioned according to lines 1. Upon the sheet or nap of the frame thus made, is placed a layer of rubber and positioned on this composite is a second sheet of framework whose flexible elements are directed according to the generatrices (line 4). Thereafter, a new layer of rubber is applied and the skirt which has thus been manufactured in a mold is vulcanized.

The skirt shown in FIG. 3 has the shape of a truncated cone being oblique and not having an axis of symmetry. As in the case of the skirt illustrated in FIG. 1, the framework is made up of two superimposed sheets or naps, the flexible elements of one of these sheets having the form of circles being substantially parallel to the bases (line 5), and the flexible elements of the other sheet being disposed according to the generatrices (line 6). This skirt may be manufactured in the same manner as that shown in FIG. 1, and, as is the case with the skirt shown in FIG. 1, if the flexible elements disposed according to the generatrices (line 6) were extended, they would intersect at the apex of the oblique truncated cone shown in FIG. 3.
It is also possible to make the framework of a skirt having the shape of an oblique truncated cone by proceeding as in the case of the skirt according to FIG. 2. In the skirt having the shape of an oblique truncated cone, the stresses due to the lateral forces to which the flexible elements of the framework are subjected are not, by reason of the variation in the inclination of the walls, the same in all of the points of the circles parallel to the bases. On the same generatrix, the stresses also vary by reason of the variation of the diameter of the sections. Lines 7 of FIG. 4 represent lines which adjoin the points where these stresses are the same.

According to the present invention, it is possible in the case of skirts having the shape of an oblique truncated cone to orient the flexible elements of the framework, which are designed to resist the lateral forces or stresses, in the direction of these lines. This renders it possible not only to cause these flexible elements to operate under the best possible conditions, but also to make the skirt lighter by providing at the different parts of the framework only the resistance which is necessary to absorb the forces or stresses to which they are exposed.

It is possible to use for this purpose flexible elements which are different by their very nature and/or constitution. It is also possible to utilize the flexible elements by varying the spacing therebetween, the flexible elements being arranged more closely or more tightly in zones where the forces or stresses are higher than in the zones where the forces or stresses are smaller.

In the modified embodiment illustrated in FIG. 5, the directions of the reinforcing flexible elements 8 and 9 correspond to those of the components of the stresses. The angles of intersection of the elements are variable in the downward direction of the skirt. Even while having a non-deformable wall which is in conformity with and follows the geometry of the theoretical outline of the skirt, it may be desirable to provide a certain elasticity in the skirt to facilitate the passage of obstacles and to compensate for instantaneous and abnormal stresses or forces. This may be achieved by making the skirt from several panels, such as 11, connected with each other by means of an elastic joint which may have a shearing operation, for example, as shown in FIGS. 6 and 7.

In the embodiments described hereinabove, the framework of the skirts is made from two sheets or naps. It is obvious that more than two such sheets or naps could be provided without departing from the spirit and scope of the present invention. This is particularly the case if a single sheet or nap does not provide sufficient resistance to the stresses or forces to which the skirt is subjected. Generally speaking, the present invention is not limited to the embodiments shown and described herein. More particularly, it may be applied in other forms or shapes of skirts, and FIG. 8 shows by way of example the application thereof to a skirt 12 having multiple lobes surrounding or enclosing smaller skirts 13.

Since modifications of this invention will be apparent to those skilled in the art, it is not desired to limit the invention to the exact constitution shown and described. Accordingly, all suitable modifications and equivalents may be resorted to which fall within the scope of the invention.

I claim:

1. A skirt for vehicles propelled and supported on at least one pressurized air cushion, said skirt comprising at least two sheets or naps formed from one another by an elastomeric layer, each sheet formed by flexible elements separated from each other and the flexible elements of each of said sheets having a direction oriented to resist orthogonally related groups of forces, the flexible elements in each of said sheets being interconnected by the elastomeric layer which separates said sheets, the flexible elements of said sheets being disposed in the direction to resist said forces to which said skirt is subjected to by said pressurized air cushion, the flexible elements of one of said sheets being disposed in the direction to resist one of said group of orthogonally related forces while the flexible elements of the other of said sheets are disposed in a direction to resist the other orthogonally related forces.

2. The skirt of claim 1 in the form of a truncated cone, wherein the flexible elements of one sheet are disposed according to the generatrices of said cone and the flexible elements of the other sheet are continuous filaments which form a helix with respect to the bases of said cone.

3. The skirt of claim 1, in the form of an oblique truncated cone one of said orthogonally groups of forces being transverse stresses the flexible elements of one sheet being disposed according to the lines adjoining the points where said transverse stresses substantially parallel to the bases are identical, and the flexible elements of the second sheet being disposed according to the generatrices of said cone.

4. The skirt of claim 3, wherein the flexible elements which are disposed to resist said transverse stresses are arranged more closely together in zones where the stresses are higher than in zones where the stresses are smaller, thus providing at the different parts of the skirt only that resistance which is necessary to absorb the force or stresses to which they are exposed.

5. The skirt of claim 3, wherein each of said sheets comprises at least two partially overlapping panels interconnected by means of a flexible joint between the overlapping portions of said panels.

6. A skirt in the form of a truncated cone, for vehicles propelled on air cushions which comprises at least two sheets separated from each other by an elastomeric layer, each sheet being formed by flexible elements separated from each other and having a direction oriented to resist specific forces and stresses, the flexible elements of said sheets being interconnected by the elastomeric layer which separates said sheets, the flexible elements of one sheet being disposed according to the generatrices of said truncated cone while the flexible elements of the other sheet are disposed substantially parallel to the bases of the cone.

7. The skirt of claim 6, wherein the flexible element is a filament which possesses a limited amount of elongation selected from the group consisting of glass fibers, metallic fibers, natural fibers and synthetic fibers.

8. The skirt of claim 7, wherein the synthetic fiber is rayon.

9. The skirt of claim 6, wherein the elastomeric layer is selected from the group consisting of a vulcanizable rubber, a self-vulcanizable material or a synthetic resin.

10. The skirt of claim 6, wherein each of said sheets comprises at least two partially overlapping panels interconnected by means of a flexible joint between the overlapping portions of said panels.

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