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(54) PNEUMATIC RUBBER TIRE FOR OFF-ROAD VEHICLES

(71) We, BRIDGESTONE TIRE KABUSHIKI KAISHA, of No. 1-1, 1-Chome, Kyobashi, Chou-Ku, Tokyo, Japan, a company organized according to the laws of Japan, do hereby declare the invention, for which we pray that a patent may be granted to us, and the method by which it is to be performed, to be particularly described in and by the following statement:—

This invention relates to a pneumatic rubber tire for off-road vehicles, for example construction vehicles such as dump trucks, scrapers and loaders, agricultural vehicles such as log skidders and log forwards or industrial vehicles such as fork lifts, platform trucks and trailers.

In general, tires of this type run on an off-road area where obstructions such as sharp rocks, metal pieces, glass pieces and stubs after tree felling are scattered thereon under a heavy load per tire. Therefore, such a tire is required to have a large resistance against damage due to cut failure and a good durability for long use.

In this type of tire, resistance to damage due to tire cuts (hereinafter referred to as the cut resistant property), resistance to separation of rubber around a reinforcing layer in the crown and other portions of the tire (hereinafter referred to as the separation resistant property), and wear resistance are the most important requirements.

Heretofore, there have been made a few attempts to improve the cut resistant property of the tire, but these attempts have not always been satisfactory. Besides, the separation resistant property in the crown and other portions may be considerably degraded. As a result, it is very difficult to provide tires having a practical durability by any of the known methods.

For instance, a first type of the conventionally proposed pneumatic tires is a so-called wire-under-tread type tire (hereinafter referred to as a W.T.U. tire), wherein a rubberized layer containing thin metallic filaments of about 10 mm length embedded therein is arranged between the tread rubber and the carcass body so as to prevent growth of the damage due to cuts started from the tire tread and extending into the interior portion of the tire. In practice, however, this first type of tire has the drawbacks that if sufficient metallic filaments to improve the cut resistant property are embedded in the rubber, premature separation failure frequently occurs inside the W.U.T. layer or between the W.U.T. layer and the tread rubber or between the W.U.T. layer and the carcass body, while if the amount of the metallic filaments used is decreased to such an extent that premature separation failure is not caused, the desired cut resistant property cannot be achieved. Thus, the W.U.T. tires have not yet been put to practical use.

A second type of conventional pneumatic tire is provided with a steel cord breaker. As is well-known, the steel cord for the tire is prepared by twisting a plurality of strands, each strand being formed by twisting a plurality of elongate steel filaments each having a filament diameter of about 0.15 to 0.3 mm. In this second type of tire, the breaker is formed by embedding such steel cords at equal intervals in rubber and is arranged between the carcass body and the tread rubber so as to prevent growth of cut failure passing through the crown portion of the tire. However, the second type of tire having such a steel cord breaker has the unavoidable drawback that separation failure is apt to be caused at the steel cord ends.

The present invention provides a pneumatic rubber tire for off-road vehicles, comprising a carcass composed of rubberized plies, each having parallel cords which are formed of organic fiber and inclined at an angle with respect to the circumferential direction of the tire, the cords of one-half or approximately one-half of the carcass plies extending in an opposite direction to the cords associated with the remaining plies to define a bias construction, and a breaker composed of at least two layers each containing parallel reinforcing elements embedded in rubber, each said reinforcing element in one of the breaker layers being composed of one helically formed filament or of a bundle of helically formed filaments assembled together without twisting, each helically formed filament being of material having a tensile strength of not less than 140 kg/mm^2, and each said reinforcing element having a modulus of elasticity 0.6 to 70 times higher than that of the said organic fiber cords of the carcass plies, and each said reinforcing element in the other or another breaker layer being composed of a stranded cord of steel filaments inclined to the circumferential direction of the tire at an angle which is not more than 8° larger and not more than 15° smaller than the said angle of the cords in the carcass plies which are substantially aligned with the said stranded cords.

By a helically formed filament there is meant a filament which delineates a cylindrical helix with the axis of the helix extending in the general direction of the reinforcing element formed by the filament or a bundle of the filaments.

In a preferred embodiment of the invention, each filament or bundle of filaments is inclined to the circumferential direction of the tire at an angle which is not more than 5° larger and not more than 10° smaller than the angle of the stranded cords constituting the reinforcing elements in the other or another of the breaker layers.

The breaker layer containing the helically formed filaments or bundles thereof as the reinforcing elements may be terminated at suitable positions in the widthwise direction of the tread, but preferably the end portions of the breaker layer containing these stranded cords constituting reinforcing elements are not located at the hump portions of the tire.

According to the invention, the carcass is a bias structure composed of rubberized plies each containing parallel cords formed of organic fiber and inclined at a given angle, preferably an angle of 23° to 45°, with respect to the circumferential direction of tire, the cords of one-half or approximately one-half of the carcass plies extending in an opposite direction to the cords associated with the remaining plies.

The formation of a tire body having such a bias carcass is substantially similar to the prior art in the fundamental construction of the so-called bias type tire. However, the invention is particularly aimed at to adapt such a tire for travel on off-roads under severe service conditions.

In such a bias carcass, if the cord angle of the carcass plies is smaller than 23°, it is difficult to deform the carcass into a toroidal shape in the tire building step. On the contrary, if the cord angle of the carcass plies is larger than 45°, an undesirable flexibility is given to the side portions of the tire so that the stability and safety of the tire are degraded.

According to the invention, the breaker circumferentially superimposed about the carcass is composed of at least two layers each containing parallel reinforcing elements embedded in rubber. The reinforcing elements used in one of the breaker layers are each composed of a helically formed filament or a bundle thereof assembled together without twisting. The tensile strength required for such heilcally formed filaments is defined by a balanced resistance to cuts penetrating into the tire, which resistance is present in the tire immediately before tread cuts are produced by for example sharp rocks when the tire rides on or is urged against these rocks. The tensile strength of the filament is made to be at least 140 kg/mm^2, preferably at least 170 kg/mm^2, when the tire is used under such conditions that comparatively mild tread cuts are produced, and at least 200 kg/mm^2 when a maximum cut resistant property is required.

As the breaker for the tire according to the invention, the rubberized layer containing the reinforcing elements composed of the above mentioned helically formed filaments or bundles is used together with a rubberized layer containing reinforcing elements each composed of a stranded cord of steel filaments. The reason why two such rubberized layers are used as the breaker is as follows.

Heretofore, there was used a steel cord breaker composed of a rubberized layer containing steel cords embedded therein. As mentioned above, such steel cords are prepared by twisting a plurality of strands, each strand being formed by twisting a plurality of thin steel filaments each having a filament diameter of about 0.15 to 0.3 mm.

Since steel cord has a very high modulus of elasticity and a high flexural rigidity, if the crown portion of the tire as a whole is largely deformed during running under a load, the steel cords tend to maintain the linearity and original length of the crown portion. On the contrary, the rubber surrounding the steel cords has a small modulus of elasticity and flexibility. As a result, a large shearing strain is caused between the steel cords and the tread rubber in contact therewith. In particular, the shearing strain becomes a maximum at the ends of the steel cords and hence the damage due to separation occurs early in use. If the tire is repeatedly used for a long time in such a damaged state, the damage due to separation becomes considerable and further use of the tire is impossible.

The term "modulus of elasticity" used herein means a value calculated from the following equation on the basis of a relationship between elongation and a force obtained by drawing an organic fiber cord or a reinforcing element composed of steel cord or a helically formed filament or bundle of such filaments under tension:

$$\text{Modulus of elasticity} = \frac{(\frac{F}{S})}{l}\ [\text{kg/mm}^2],$$

wherein F represents a force (kg) at an elongation of 1%, S represents the sectional area (mm^2) of a material to be drawn, and l represent an elongation of 1%. According to this equation, the modulus of elasticity of nylon cord is about 1.2×10^2 kg/mm² and that of steel cord is about 200×10^2 kg/mm².

Helically formed filaments of a metal such as steel suitably having a filament diameter of 0.1 to 1.0 mm, more preferably about 0.13 to 0.5 mm, or bundles of such helically formed filaments assembled together without twisting are used as reinforcing elements having an improved cut resistant property in the breaker layer of the tire according to the invention.

Each reinforcing element composed of a helically formed filament has a modulus of elasticity within a range of 0.7×10^2 to 80×10^2 (kg/mm²), preferably 0.7×10^2 to 60×10^2 (kg/mm²). That is, the modulus of elasticity of a reinforcing element composed of a helically formed filament is 0.6 to 70 times higher than that of the organic fiber cords used in the carcass plies, while the modulus of elasticity of the steel cord is about 200 times higher than that of the organic fiber cord.

According to the invention, the modulus of elasticity of each reinforcing element composed of a helically formed filament is so selected that the ratio of the other modulus of elasticity of such reinforcing element to that of the organic fiber cord is within a range of 0.6 to 70, preferably 0.6 to 50. If such a ratio is larger than 70, the difference between the modulus of elasticity of the reinforcing element and that of the tread rubber becomes considerably large, and as a result the shearing strain between the reinforcing elements and the adjoining tread rubber becomes large during the rotation of the tire and damage due to separation is liable to be caused. When the modulus of elasticity of the reinforcing element comes near that of the organic fiber cord, damage due to separation hardly occurs. However, if the above ratio is smaller than 0.6, the rigidity of the reinforcing element becomes excessively small, so that the tire is apt to be deformed more and hence the wearing of the tread rubber is accelerated.

According to the invention, by constructing the breaker of at least two rubberized layers each containing the different reinforcing elements, there is provided a pneumatic rubber tire for off-road vehicles which prevents occurrence of the damage due to separation, which was liable to be caused in the conventional steel cord breaker, sufficiently utilizes the high cut resistant property inherent to steel and has excellent wear resistance and high durability as compared with a breaker using only helically formed filaments. That is, the rubberized layer containing steel cords as the reinforcing elements for the breaker of the tire according to the invention is not effective against certain speical cuts but exhibits an excellent cut resistant property against general cuts. Further, this breaker layer increases the rigidity of the crown portion and hence exhibits an excellent wear resistance owing to its high modulus of elasticity. However, such a high modulus of elasticity causes a large relative strain between the steel cords and the adjoining tread rubber, and as a result the separation resistant property is considerably degraded. Therefore, it is necessary to limit the number of steel cord layers utilized. On the other hand, the rubberized layer containing the helically formed filaments or bundles thereof as reinforcing elements for the breaker of the tire according to the invention considerably decreases the relative strain between the reinforcing elements and the adjoining tread rubber as compared with the case of using the steel cords because the modulus of elasticity of these reinforcing element is lower than that of the steel cords and as a result such a layer exhibits not only a very high separation resistant property but also a considerably improved cut resistant property against any kind of cuts. Therefore, there is no limitation relating to the number of such layers utilized.

We have confirmed from many experimental results that a synergetic effect is developed by combining the steel cord reinforced layer with the helically formed filament reinforced layer in the breaker, and as a result, excellent properties are given to the tire for use in off-road vehicles.

That is, the invention makes it possible to combine in the breaker layer rubberized layers containing two different types of reinforcing elements in various forms in practice. For instance, a first rubberized layer containing helically formed filaments or bundles thereof as the reinforcing elements may be arranged outside a second rubberized layer containing steel cords as the reinforcing elements, and vice versa. Furthermore, as second such rubberized layer may be sandwiched between two such first rubberized layers, and vice versa.

In any case the number of each of the first and second rubberized layers used may be one or more. Such modified constructions of the breaker are optionally selected depending upon matters relating to the tire design inclusive of the use conditions of the tire and production costs. Moreover, an additional rubberized layer containing fiber cords as reinforcing elements may be used in the breaker besides the first and second rubberized layers. Alternatively, such fiber cords may be incorporated into any one of the first and second rubberized layers as a part of the reinforcing elements, if necessary.

According to the invention, the rubberized layer containing steel cords as the reinforcing elements for the breaker should be arranged relative to the circumferential direction of tire so that its steel cords are inclined at an angle which is not more than 8° larger and not more than 15° smaller than the angle of the cords in the carcass plies which are substantially aligned with the steel cords.

In the rubberized layer containing helically formed filaments or bundles thereof as the reinforcing elements, the modulus of elasticity of the reinforcing elements is very small as compared with that of the steel cords and comes near that of the tread rubber. Thus, it will be anticipated that the rigidity of this rubberized layer as a whole becomes small due to the decrease of the modulus of elasticity and hence the wear resistance of the tread rubber is degraded. Therefore, in order to arrange the rigidity of the helically formed filament reinforced layer closer to that of the steel cord reinforced layer to thereby improve the wear resistance of the tread rubber, the helically formed filament reinforced layer is preferably arranged relative to the circumferential direction of tire so that the angle of the helically formed filament reinforcement is not more than 5° larger and not more than 10° smaller than the angle of the steel cords used as reinforcing elements for the breaker.

In order to prevent growth of the damage due to cuts started from the tread portion of pneumatic bias tires for off-road vehicles, it has been the common practice to arrange a breaker composed of two or more steel cord reinforced layers between the carcass ply and the tread rubber wherein one of the steel cord layers has a width somewhat larger than the tread width and the other steel cord layer near the tread portion has a width narrower than the tread width. In such a bias tire, it has been well-known that the radius of that portion of the tire which makes contact with the ground (effective rotational radius) becomes small during the rotation of tire under load and at the same time the tread width of this portion becomes narrow, while when that portion of the tire which makes contact with ground is not subjected to load in the course of the rotation, the radius becomes large and at the same time the tread width is turned to the original width. Upon observation of such a phenomenon, particularly behaviour in the internal portion of the tread, it has been confirmed that the angle of the organic fiber cords used in the carcass plies as well as the angle of the steel cords used in the breaker at that portion of the tire which makes contact with the ground under load are variously changed. Such a change of cord angles is indefinately repeated until the tire becomes useless. On the other hand, the modulus of elasticity of the steel cords is considerably higher than that of the tread rubber. This considerably large difference between the modulus of elasticity of the steel cords and that of the tread rubber results in occurrence of large shearing strain between the steel cords and the tread rubber contacting therewith when the steel cords which make contact with the ground under load are subjected to change of cord angle. This phenomenon has been examined in detail with respect to damaged tires provided with steel cord breakers to yield recognition of the following; that is, the damage due to separation is not observed at end portions of the breaker extending near the side portions over the tread width because the shearing strain between the steel cords and the adjoining tread rubber during the rotation of tire under load gradually increases from the crown center to the hump portions, and is a maximum at the hump portions and rapidly decreases beyond the hump portions. On the contrary, at end portions of the steel cords terminated at the hump portions there is caused a considerably large shearing strain between the steel cords and the adjoining tread rubber due to the change of the steel cord angle as described above, and as a result damage due to separation is caused and gradually spread. Therefore, it is frequently occurred that steel cord breaker tires become useless after relatively little use though they possess a considerably high cut resistant property. On the basis of such recognition, the breaker of the tire according to the invention composed of at least two rubberized layers is preferably so arranged that the ends of the breaker layer containing steel cords as the reinforcing elements are arranged so as not to be located at the hump portions where damage due to separation is liable to occur, while the breaker layer containing helically formed filaments or bundles thereof as the reinforcing elements may be located at any position because such layer itself does not cause damage due to separation as mentioned above.

The term "tread width" used herein means the distance on the tread surface between the most thick portions of tread rubber gauge at both ends of the crown portion when the tire is cut along a plane including the rotational axis of tire. The term "hump line" used herein means a line drawn normal from the tread surface having the most thick portion of the tread rubber toward the carcass ply, and hence the term "hump portion" used herein means the area around where the hump line intersects the outermost ply of the carcass plies or the tread rubber near the carcass plies.

We have already confirmed from experimental results relating to the filament diameter of the helically formed filaments that when helically formed filaments of the same material are used as the reinforcing elements against any type of cuts, the cut resistant property of the tire depends upon the total sectional area of the filaments included in the section of the tire due to cut failure but does not depend upon the size of the sectional area or diameter of each filament. Therefore, it is preferable that the filament diameter of the helically formed filaments is as small as possible in order to make the internal stress of the filament uniform. In this connection, there are preferably used helically formed filaments having a filament diameter of 0.1 mm to 1.0 mm.

If the filament diameter is smaller than 0.1 mm, the filaments frequently break in the step of forming the helically formed filaments. As a result, it is clear that the use of such thin filaments is not economical. On the contrary, if the filament diameter is larger than 1.0 mm, the internal stress produced in the step of forming the helically formed filaments becomes excessive. In addition, the torsional shearing stress produced when the force for expanding or contracting the filaments is applied thereto in their lengthwise direction is concentrated toward the outer portion of the filaments. As a result, in order to give the filaments the strength necessary for withstanding the same exterior force, the total sectional area of the large diameter filaments must be larger than that of the thin filaments, so that a greater amount of material is required. Hence, it is clear that the use of such large diameter filaments is not economical. As seen from the above, the filament diameter should preferably lie within the above mentioned range of 0.1 mm to 1.0 mm.

In the practice of the invention, the breaker of the above mentioned construction is usually arranged between the tread rubber and the carcass ply. However, the breaker may be arranged in the tread rubber or in the carcass plies near the tread having regard to the use of the tire. Moreover, the breaker may be divided at suitable intervals in its widthwise direction.

The breaker is not always symmetrical with respect to the equatorial plane of tire and may be asymmetrical having regard to the use of the tires.

In addition, at least one rubberized layer of cords made of an organic fiber such as nylon (breaker protect layer) may be arranged as a cut protector by superimposing it outside the breaker (near the tread) with a width larger than that of the breaker or along both side edges of the breaker so as to improve the recap property of the tire.

The organic fiber cord used in the carcass plies and the breaker protector layer may suitably be made of rayon, vinylon or polyester in addition to nylon. The helically formed filaments and the stranded steel cords constituting the reinforcing elements for the breaker are preferably made of filament materials having a good adherence to rubber or are subjected to a treatment for adhering them to rubber, and are for example a brass plated steel filaments, aromatic polyamide fibers having a high modulus of elasticity or glass fibers.

The invention will be further described, by way of example only, with reference to the accompanying drawings, wherein:

Fig. 1 is a cross-sectional view of one-half of a tire according to the present invention;

Fig. 2 is a graph illustrating experimental test results of the separation resistant property of a tire according to the invention compared with those of conventional tires; and

Figs. 3 to 5 are cross-sectional views of modified forms of tires according to the present invention, respectively.

Fig. 1 is a radial cross-sectional view of one-half of a pneumatic tire according to the invention, for a construction vehicle wheel, the section containing the rotational axis of tire. This tire is of 17.5-25 12PR in size (12PR indicates the size on the basis of cotton yarn). In the present embodiment, a bead member 1 is composed of two sets of bead cores *1a*, *1b*. A carcass 2 is composed of 8 plies in total, each ply being composed of nylon cord of 1,260 denier/two strands.

Four plies *2a* of the total 8 plies of the carcass 2 are wound around the bead core *1a* from the inside toward the outside thereof and secured to the bead member 1. Another two plies *2b* are wound around the bead core *1b* from the inside toward the outside thereof and secured to the bead member 1. The remaining two outside plies *2c* are extended from the outside toward the inside of the bead cores *1a*, *1b* along their lower surfaces and are secured at their ends to a toe portion *1c* of the bead member 1.

The cords of each ply of the carcass 2 are inclined at an angle of about 36° with respect to the circumferential direction of tire as measured at the center of a tire crown portion. These cords of the carcass plies alternately extend along two opposite directions symmetrically inclined at about 36° with respect to the circumferential direction of the tire crown portion.

In the crown portion 3 of the tire, about the outside of the carcass 2 is superimposed a breaker 4 of two-layered structure. In the breaker 4, a layer 4*a* is composed of a rubberized fabric containing a plurality of stranded steel cords having a strand construction of 1 × 4 + 6 × 4 + 1 (the filament diameter is 0.175 mm and the cord diameter is 1.26 mm) embedded therein as reinforcing elements. The number of steel cords per 5 cm is approximately 18 and these cords are inclined at an angle of about 36° with respect to the circumferential direction of the tire. Another layer 4*b* is composed of a rubberized fabric containing a plurality of bundles of helically formed filaments (the filament diameter is 0.25 mm and the number of filaments is 14) embedded therein as reinforcing elements. The number of the bundles per 5 cm is approximately 18 and these bundles are inclined at an angle of about 36° with respect to the circumferential direction of tire.

Fig. 2 illustrates the improved separation resistant property and durability of the tire constructed as above described manner (referred to the tire according to example 1 of the invention). This figure shows experimental tests obtained by an indoor drum testing machine by plotting running time in hours on the abscissa and plotting load x speed per hour in ton-kilometers per hour on the ordinate. In the present experimental test, the tire was pressurized to the standard internal pressure of 3.5 kg/cm², the speed was made constant at 11 km/hr, and the load was increased from 60% to 170% in a stepwise manner as shown in Fig. 2. In this case, 100% load corresponds to 6.135 kg (standard load for 17.5-25 tire as defined according to JIS).

In Fig. 2, point A represents the test result of a conventional steel breaker tire, point B the test result of a conventional nylon breaker tire, and point C the test result of the tire according to the invention. As shown by the point A, the conventional steel breaker tire exceeded its limit at the third load step, thus resulting in breaker end separation. On the contrary, as shown by the point C, the tire according to the invention safely passed the third load step and arrived at the fifth load step where the tire exceeded its limit and separation at the breaker due to overheating occurred. In this case, there was not observed the occurrence of separation at the ends of each bundle made of the helically formed filaments in the breaker layer 4*b*.

The above experimental tests have yielded the surprising result that the invention gives the same effect as the conventional nylon breaker tire which undergoes separation at the point B of the fifth load step although the steel cords liable to cause the separation are used as the reinforcing element for the breaker.

Fig. 3 is a radial cross-sectional view of one-half of a tire having the same structure as described in Fig. 1, except that the breaker 4 is composed of two layers 4*a* and two layers 4*b* and the arrangement of the breaker layers 4*a*, 4*b* is reversed with respect to the case of Fig. 1.

The tire shown in Fig. 3 gave the substantially same result as the tire shown in Fig. 1 when the durability of the tire was examined by an indoor drum testing machine in the same manner as described above.

In the tires shown in Figs. 1 and 3, the modulus of elasticity of the nylon cord used in each ply of the carcass 2 was 1.2 × 10² kg/mm², and that of the reinforcing elements composed of bundles of helically formed steel filaments in the breaker layer 4*b* was 2.5 × 10² kg/mm². Further, the tensile strength of the helically formed steel filaments was 270 kg/mm².

In the embodiment shown in Fig. 4, the arrangement of the breaker 4 composed of an outer layer 4*a* and an inner layer 4*b* is the same as in Fig. 3 except that both ends of the breaker 4 are not located in the vicinity of the hump portions 5 of the tire, and further an additional reinforcing layer 6 is arranged between the breaker layers 4*a* and 4*b*. This additional reinforcing layer 6 is composed of a rubberized ply containing 40 stranded nylon cords per 5 cm, the stranded nylon cord being composed of 1,260 denier/two strands. These cords are inclined at the same angle as that of the breaker 4, but extend in a direction opposite to the breaker layer 4*b*.

In the embodiment shown in Fig. 5, the arrangement of the breaker 4 composed of an inner layer 4*a* and an outer layer 4*b* is the same as in Fig. 1 except that the ends of the breaker layer 4*a* are not located in the vicinity of the hump portions 5 of tire but the ends of the breaker layer 4*b* terminate in the vicinity of the hump portions 5.

In Figs. 4 and 5, a dot-dash line represents the hump line of the tire.

WHAT WE CLAIM IS:—

1. A pneumatic rubber tire for off-road vehicles, comprising a carcass composed of rubberized plies, each having parallel cords which are formed of organic fiber and inclined at an angle with respect to the circumferential direction of the tire, the cords of one-half or approximately one-half of the carcass plies extending in an opposite direction to the cords associated with the remaining plies to define a bias construction, and a breaker composed of at least two layers each containing parallel reinforcing elements embedded in rubber, each said reinforcing element in one of the breaker layers being composed of one helically formed filament or of a bundle of helically formed filaments assembled together without twisting, each helically formed filament being of material having a tensile strength of not less than 140 kg/mm², and each said reinforcing element having a modulus of elasticity 0.6 to 70 times

higher than that of the said organic fiber cords of the carcass plies, and each said reinforcing element in the other or another breaker layer being composed of a stranded cord of steel filaments inclined to the circumferential direction of the tire at an angle which is not more than 8° larger and not more than 15° smaller than the said angle of the cords in the carcass plies which are substantially aligned with the said stranded cords.

2. A pneumatic rubber tire as claimed in claim 1, wherein each said filament or bundle of filaments is inclined to the circumferential direction of the tire at an angle which is not more than 5° larger and not more than 10° smaller than the said angle of the said stranded cords constituting the reinforcing elements in the other or another of said breaker layers.

3. A pneumatic rubber tire as claimed in claim 1 or 2, wherein the end portions of the breaker layer containing the said stranded cords constituting reinforcing elements are not located at the hump portions of the tire.

4. A pneumatic rubber tire for off-road vehicles, substantally as herein described with reference to, and as shown in, Figure 1, Figure 3, Figure 4 or Figure 5 of the accompanying drawings.

MARKS & CLERK.

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FIG_1

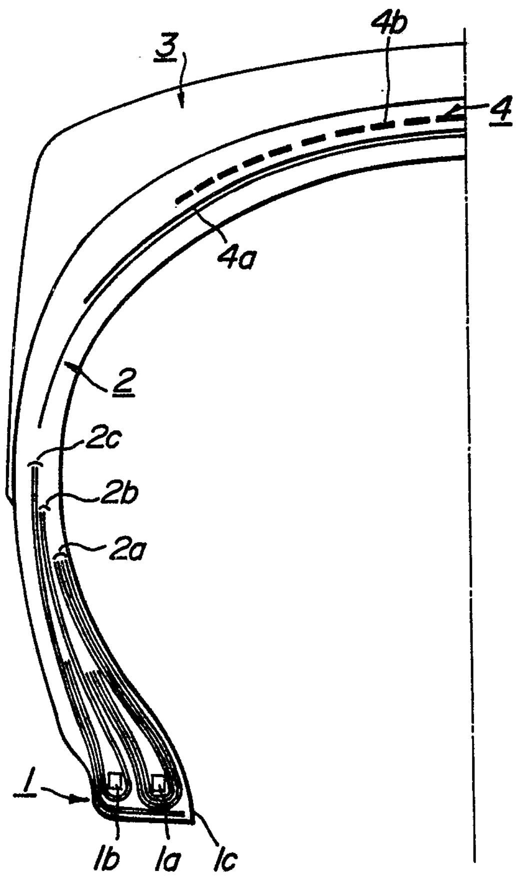

FIG_2

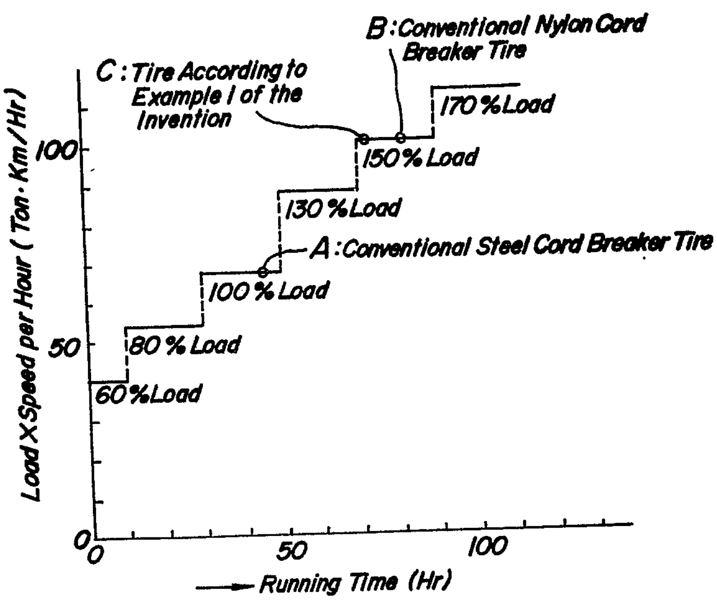
B: Conventional Nylon Cord Breaker Tire
C: Tire According to Example I of the Invention
170 % Load
150 % Load
130 % Load
A: Conventional Steel Cord Breaker Tire
100 % Load
80 % Load
60 % Load
Load X Speed per Hour (Ton · Km/Hr)
100
50
0
0
50
100
Running Time (Hr)

FIG. 3

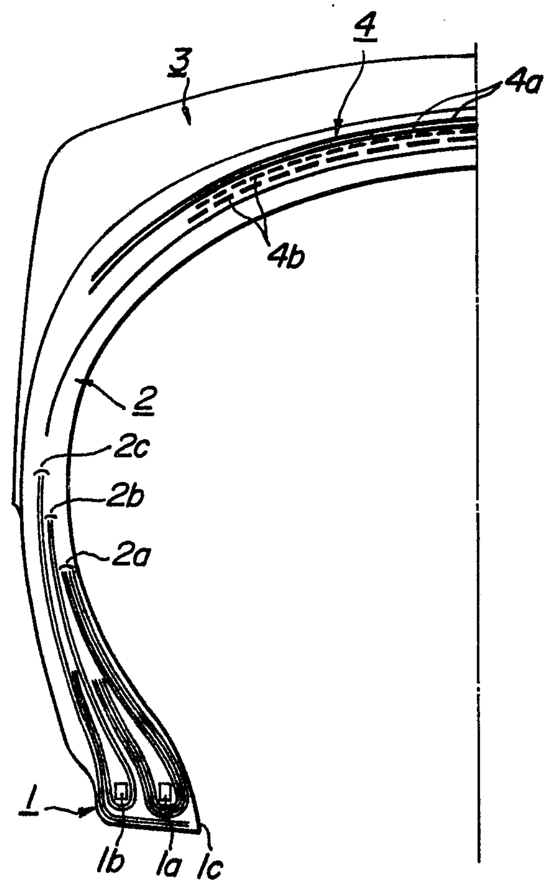

FIG. 4

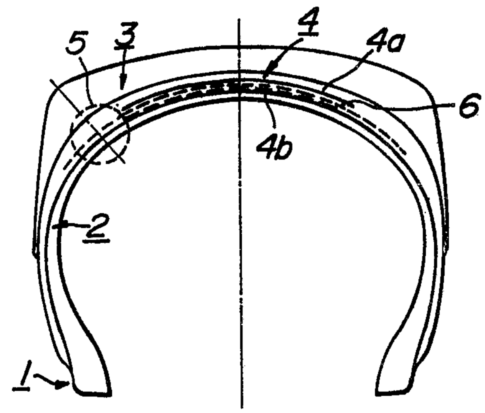

FIG. 5