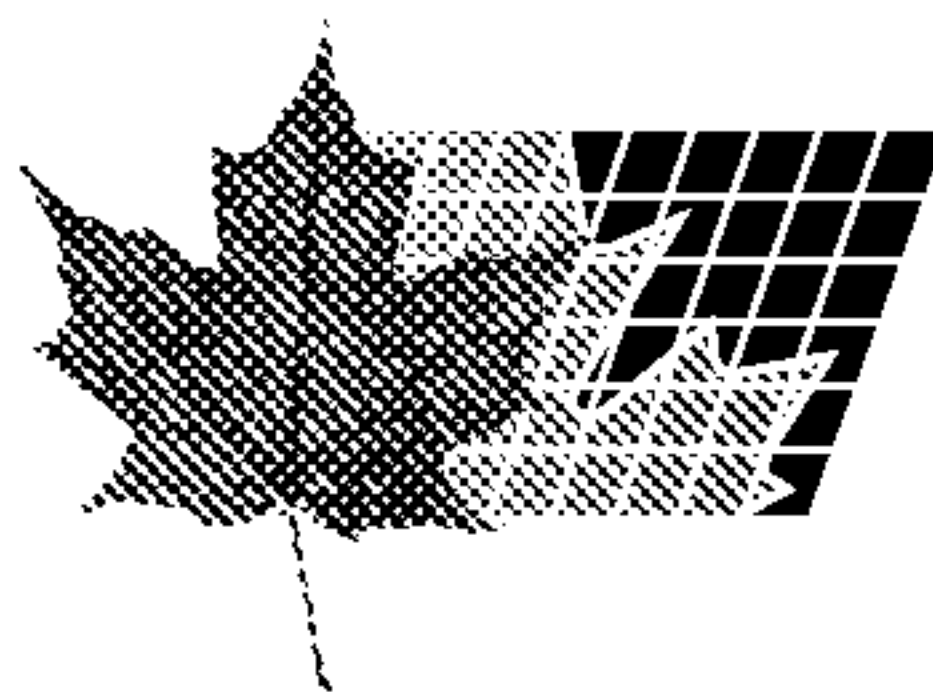
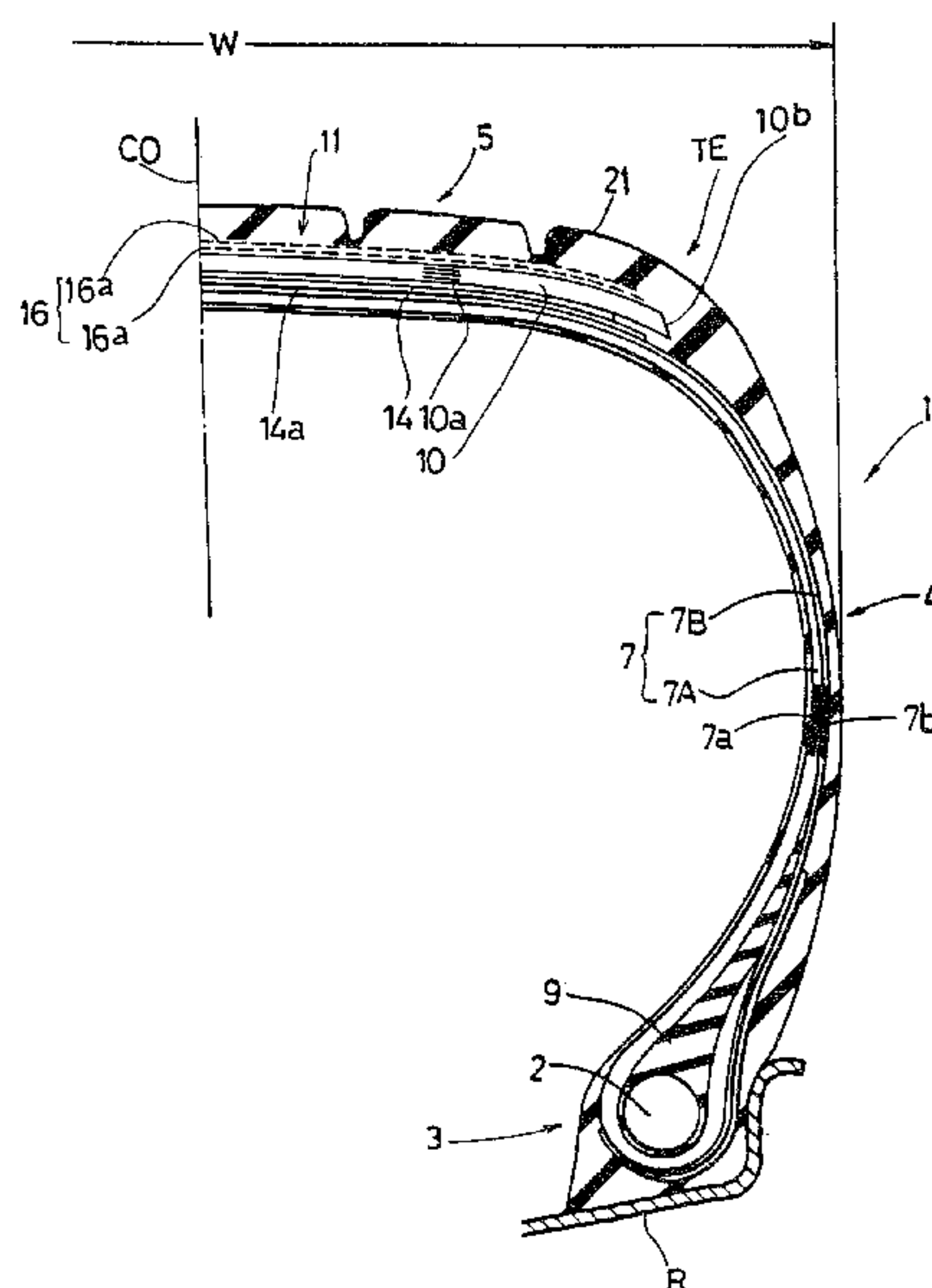




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(54) **PNEU RADIAL HAUTE RESISTANCE POUR VITESSE
ELEVÉES**
(54) **HEAVY DUTY, HIGH-SPEED, RADIAL TIRE**



(57) A heavy duty, high-speed radial tire is provided herein. The tire includes a pair of bead portions, each portion having a bead core disposed therein. A carcass is turned up around the bead cores and is composed of at least one ply of carcass cords which are laid at angles in a range from 75 degrees to 90 degrees with respect to the tire equator, the carcass cords being aromatic polyamide fibre cords. An aromatic polyamide fibre cord belt structure is disposed radially outside the carcass and inside a rubber tread. The belt structure further includes a breaker which is disposed radially outside the carcass and which is composed of at least one ply of the aromatic polyamide fibre belt cords which are laid at angles of from 10 to 30 degrees to the tire equator, and a band which is disposed radially outside the breaker and which is composed of plurality of plies of at least one aromatic polyamide fibre belt cord which is wound spirally and continuously from one edge to other edge thereof to be laid at an angle of from 0 to 5 degrees to the tire equator. The product $T\sqrt{D}$ of the cable twist number (T), (i.e., turns/10 cm) of the belt cord and the square root of the total denier number (D) (i.e., deniers) of the belt cord, is from 2.466×10^3 to 3.036×10^3 . The elongation (E) (in %) at breakage of the belt cord divided by the total denier number (D) of the belt cord, is from 7.78×10^{-4} to 12.22×10^{-4} . The product $T\sqrt{D}$ of the cable twist number (T) of the carcass cord and the square root of the total denier number (D) of the carcass cord, is from 2.466×10^3 to 3.036×10^3 . The elongation (E) at breakage of the carcass cord divided by the total denier number (D) of the carcass cord, is from 7.78×10^{-4} to 12.22×10^{-4} .



ABSTRACT

A heavy duty, high-speed radial tire is provided herein. The tire includes a pair of bead portions, each portion having a bead core disposed therein. A carcass is turned up around the bead cores and is composed of at least one ply of carcass cords which are laid at angles in a range from 75 degrees to 90 degrees with respect to the tire equator, the carcass cords being aromatic polyamide fibre cords. An aromatic polyamide fibre cord belt structure is disposed radially outside the carcass and inside a rubber tread. The belt structure further includes a breaker which is disposed radially outside the carcass and which is composed of at least one ply of the aromatic polyamide fibre belt cords which are laid at angles of from 10 to 30 degrees to the tire equator, and a band which is disposed radially outside the breaker and which is composed of plurality of plies of at least one aromatic polyamide fibre belt cord which is wound spirally and continuously from one edge to other edge thereof to be laid at an angle of from 0 to 5 degrees to the tire equator. The product $T\sqrt{D}$ of the cable twist number (T), (i.e., turns/10 cm) of the belt cord and the square root of the total denier number (D) (i.e., deniers) of the belt cord, is from 2.466×10^3 to 3.036×10^3 . The elongation (E) (in %) at breakage of the belt cord divided by the total denier number (D) of the belt cord, is from 7.78×10^{-4} to 12.22×10^{-4} . The product $T\sqrt{D}$ of the cable twist number (T) of the carcass cord and the square root of the total denier number (D) of the carcass cord, is from 2.466×10^3 to 3.036×10^3 . The elongation (E) at breakage of the carcass cord divided by the total denier number (D) of the carcass cord, is from 7.78×10^{-4} to 12.22×10^{-4} .

(a) TITLE OF THE INVENTION

HEAVY DUTY, HIGH-SPEED, RADIAL TIRE

(b) TECHNICAL FIELD TO WHICH THE INVENTION RELATES

5 The present invention relates to a heavy duty, high-speed radial tire, in which various tire performances, e.g., structural durability and resistance to high internal pressure, are improved.

10 (c) BACKGROUND ART

 Heavy duty, high-speed radial tires, for example, aircraft tires for jumbo jets, are required to have the following characteristics: a durability against repeating large deformation since the tire deformation when landing is
15 very large; a resistance to high-speed running under a severe loaded condition; to be able to withstand a very high internal pressure, for example 10 to 16 kgf/cm² since the designed pressure for such a tire is very high; to be able to withstand a taxi condition in which the running speed is relatively low
20 but in which the tire is subjected to a heavy load for a long time; and to be able to incur an increase in the cornering force to improve stability when the aircraft turns on the ground.

 Recently, belted radial structures have been widely used
25 for such aircraft tires. For the belt, nylon cords have been used rather than heavier steel cords in order to reduce the tire weight. However, nylon cords are inferior in tensile strength, which results in an insufficient resistance to high internal pressure, and sometimes results in a poor resistance
30 to wear under severe service conditions.

 It has been suggested to use an aromatic polyamide fibre cord as the belt cord, because aromatic polyamide fibre cords have a very large tensile strength and a very high modulus like a steel cord, but the specific gravity is as light as
35 nylon. However, the results when the prior aromatic polyamide

fibre cords were used for the belt were not as good as expected since the prior aromatic polyamide fibre cords were relatively easily broken when folded (when the tire was deformed largely), and the adhesion to rubber was inferior, owing to its high degree of crystallization.

(d) DESCRIPTION OF THE INVENTION

It is therefore, an object of one aspect of the present invention to provide a heavy duty, high-speed belted radial tire, in which various tire performances, e.g., structural durability, resistance to high internal pressure, cornering performance and the like, are improved.

According to one aspect of the present invention, a heavy duty, high-speed radial tire is provided, which includes a pair of bead portions, each such bead portion having a bead core disposed therein, a carcass which is turned up around the bead cores and which is composed of at least one ply of carcass cords which are laid at angles in a range from 75 degrees to 90 degrees with respect to the tire equator, the carcass cords being aromatic polyamide fibre cords, and an aromatic polyamide fibre cord belt structure which is disposed radially outside the carcass and inside a rubber tread. The belt structure includes a breaker which is disposed radially outside the carcass and which is composed of at least one ply of the aromatic polyamide fibre belt cords which are laid at angles of from 10 to 30 degrees to the tire equator, and a band which is disposed radially outside the breaker and which is composed of plurality of plies of at least one aromatic polyamide fibre belt cord which is wound spirally and continuously from one edge to other edge thereof to be laid at an angle of from 0 to 5 degrees to the tire equator. In such belt structure, the product $T\sqrt{D}$ of the cable twist number (T) (turns/10 cm) of the belt cord and the square root of the total denier number (D) (deniers) of the belt cord, is in a range from 2.466×10^3 to 3.036×10^3 ; the elongation (E) (in %)

at breakage of the belt cord divided by the total denier number (D) of the belt cord, is in a range from 7.78×10^{-4} to 12.22×10^{-4} ; the product $T\sqrt{D}$ of the cable twist number (T) of the carcass cord and the square root of the total denier number (D) of the carcass cord, is in a range from 2.466×10^3 to 3.036×10^3 ; and the elongation (E) at breakage of the carcass cord divided by the total denier number (D) of the carcass cord, is in a range from 7.78×10^{-4} to 12.22×10^{-4} .

By another aspect of this invention, a heavy duty, high-speed radial tire is provided including a carcass which is turned up around bead cores which are disposed one in each bead portion of the tire, and composed of at least one ply of cords laid at angles of no less than 75 degrees and no more than 90 degrees with respect to the tire equator, and a belt which is disposed radially. Outside the carcass and inside a rubber tread, the belt includes a band belt and a breaker belt which are disposed radially inside the band belt. The breaker belt is composed of a plurality of plies of breaker belt cords which are laid at angles of from 10 to 30 degrees to the tire equator so that the breaker belt cords in each ply cross the breaker belt cords in the adjacent ply, the band belt being composed of a plurality of band plies, the breaker belt cords and the at least one band belt cord comprising aromatic polyamide fibre cords, each satisfying the following conditions, namely, the twist coefficient (TN) of each the belt cord being not less than 2.466×10^3 and not more than 3.036×10^3 ; and the elongation E (in %) at breakage of each belt cord divided by the total denier number (D) of the cord, being not less than 7.78×10^{-4} and not more than 12.22×10^{-4} . The twist coefficient (TN) is the product $T\sqrt{D}$ of the cable twist (T) (turns/10 cm) of the cord and the square root of the total denier number (D) (deniers) of the cord. Each band ply is made of at least one band belt cord which is wound spirally and continuously from one edge to the other edge of the ply,

so that the cord angle is in the range of from 0 to 5 degrees to the tire equator.

By one variant of these two aspects of the invention, the thickness of the wound belt cord in each band belt ply is larger at the tire equator than at the edge parts of the ply.

By another variant thereof, the thickness of the wound belt cord in the band is larger at the tire equator than at the edge parts of the band.

By a still variant thereof, the belt cords are rubberized with a topping rubber composition. By one variation thereof, the 100% modulus of the topping rubber of the belt cord is in the range of 30 to 70 kgf/sq. cm. By another variation thereof, the elongation at breakage of the topping rubber of the belt cord is in the range of 200 to 500%. By still another variation thereof, the adhesion of the belt cord to the belt topping rubber is not less than 21.0 kgf/cm.

By a still further variant thereof, the carcass comprises an inner layer which is turned up around the bead cores from the inside to the outside of the tire, and an outer layer which is turned up around the bead cores from the outside to the inside of the tire so as to wrap the turned up portions of the inner layer.

By still a further variant thereof, the inner layer is composed of a plurality of plies and wherein the outer layer is composed of a plurality of plies.

(e) DESCRIPTION OF THE FIGURES

In the accompanying drawings, the sole figure, Fig. 1, is a sectional view showing a right half of an embodiment of one aspect of the present invention.

(f) ONE MODE FOR CARRYING OUT THE INVENTION

In the drawing, the radial tire 1 is an aircraft tire of size 46 x 17R20. The tire is mounted on a regular rim R and is inflated to normal pressure.

The tire 1 has a pair of bead portions 3, a tread portion 5 and a pair of sidewall portions 4. The tire 1 comprises a pair of bead cores 2 which are disposed one in each bead portion 3 and a carcass 7 extending between the bead portions 3 through the sidewall portions 4 and the tread portion 5.

The carcass 7 in this embodiment comprises an inner layer 7A and an outer layer 7B. The inner layer 7A is composed of plural plies 7a, in this example four plies, each turned up around the bead cores 2 from the inside to the outside of the tire.

The outer layer 7B is composed of plural plies 7b, in this example two plies, each turned up around the bead cores 2 from the outside to the inside of the tire 1 so as to wrap the turned up portions of the inner layer 7A.

Each of the carcass plies 7a and 7b is composed of cords which are arranged radially of the tire at angles of 75 to 90 degrees to the tire equator. In the embodiment shown, the cords are inclined with respect to the tire equator at 85 degrees so that the cords of each of the carcass plies 7a and 7b cross the cords of the adjacent carcass ply, whereby the lateral rigidity of the tire is increased.

The bead portions 3 are each provided radially outside of the bead core 2 with a rubber bead apex 9, which extends radially outwardly and taperingly from the bead core 2 to increase the bead rigidity.

The tread portion is provided with a belt structure 11 between the carcass 7 and a rubber tread 5, which is disposed on the carcass. The belt structure 11 in this embodiment is composed of three layers comprising a band 10, a breaker 14 and a protector 16. The band 10 is located in the centre thereof, and the breaker 14 is disposed between the band 10 and the carcass 7. The protector 16 is disposed between the band 10 and the tread 5.

The band 10 comprises plural plies 10a of cords which are arranged at no more than 5 degrees to the tire equator CO, since the main part thereof is a hoop for the tread portion.

5 The widths of the band plies 10a are decreased gradually in the radially-outward direction, as shown in Fig. 1, and thereby the side profile 10b of the band (cords) 10 as a whole is inclined to be almost parallel with the outer surface of the tire buttress part, namely, an upper part of the sidewall portion 4. The maximum width of the band 10, that is, the
10 width of the radially-innermost widest ply 10a in this example, is 65 to 85% of the section width W of the tire.

In connection with the angles of the cords 10, the band plies 10a (cords) are inclined in the reverse direction in turns with respect to the tire equator.

15 The purpose of the above-mentioned breaker 14 is to increase the rigidity of the tread portion 5 in the widthwise direction of the tread 5 to improve the cornering force of the tire.

The breaker cords are preferably arranged so as to form
20 a triangular structure in combination with the carcass cords. The above-mentioned band cords are respectively inclined at 75 to 90 degrees, and at no more than 5 degrees as explained above.

Therefore, the breaker 14 is composed of at least one ply
25 14a of cords which are arranged at 0 to 70 degrees with respect to the tire equator, more preferably at 10 to 30 degrees. In the example shown, the breaker 14 is composed of two plies of cords which are laid at 19 degrees. The plies are inclined in the reverse direction in turns with respect to
30 the tire equator. However, when the inclination of the carcass plies are relatively great, for example, when the carcass cord angle to the tire equator is 75 to 80 degrees, the inclination of the breaker cords 14a may be set at almost 0 degrees to the tire equator.

Preferably, the breaker 14 is formed at a narrower width than the band 10. The edges of the breaker ply 14a are respectively terminated beneath the edge portions of the band and axially inside the edges of the band. However, it may be possible to terminate the edges of the breaker ply 14a so as to align with the edges of the band 10, or so as to project slightly therefrom.

Thus, by the breaker 14 itself and moreover by the resultant triangular cord structure, the rigidity in the widthwise direction of the tread is increased to improve the cornering force, and further the structural durability can be improved.

The purpose of the protector 16 is to provide a resistance to cutting from the outside of the tire, and at the same time to bridge the difference in rigidity between the rubber tread 5 and the band 10 to mitigate shearing stress therebetween. The protector 16 is composed of at least one ply of cords which are laid at larger angles than the band cord angle. In this embodiment, two plies 16a of cords are arranged at 27 degrees to the tire equator.

The belt cords of the belt structure, in this embodiment the cords of the band and breaker plies, are the same cords which are composed of twisted aromatic polyamide fibre strands. The twist coefficient (TN) of the cord is not less than 2.466×10^3 , and is not more than 3.036×10^3 . The twist coefficient (TN) is herein defined as the product $\sqrt{D}$ of the cable twist number (T) (turns/10 cm) multiplied by the square root of the total denier number (D) (deniers) of the cord.

If the twist coefficient is less than 2.466×10^3 , the elongation of the cord is small, and the cornering performance of the tire is deteriorated. If the twist coefficient is more than 3.036×10^3 , the elongation of the belt cord becomes large to lower the hooping effect of the belt structure, which results in loss of resistance to ply separation and thereby the structural durability is deteriorated.

Further, in this embodiment, the elongation (E) (in %) of the belt cord when broken by increasing the cord load divided by the above-mentioned total denier number (D), is preferably not less than 7.78×10^{-4} and not more than 12.22×10^{-4} . If the quotient (E/D) is less than 7.78×10^{-4} , the stretch of the belt when the tire is inflated is small, which results in decrease in the ability to mitigate compressive stress which acts in the tread portion and the bead portions when the tire is deformed. On the other hand, if (E/D) is more than 12.22×10^{-4} , the stretch of the belt becomes so large that the problem of belt edge separation occurs.

The belt cords are topped by a rubber to form the band ply 10a and the breaker ply 14a, and similarly protector plies 16a are formed.

The topping rubber has to possess not only a low heat-generating characteristic but also an appropriate stiffness not to disturb the above-mentioned characteristics of the belt cord. For this purpose, a rubber composition is preferably used which has the following elastic characteristics: the 100% modulus is 30 to 70 kgf/cm²; and the elongation at rupture is not less than 200% and not more than 500%. Further the base material of the rubber composition is composed of one or more of natural rubber or synthetic isoprene rubber. Furthermore, the content of carbon black in the rubber composition is 50 to 70 parts by weight. When the carbon content is less than 50 parts by weight, the composition cannot be reinforced. When the carbon content exceeds 70 parts by weight, the heat-generation has a tendency to increase.

Further, when the 100% modulus is less than 30 kgf/cm², the heat-generation has a strong tendency to increase. On the other hand, when the 100% modulus exceeds 70 kgf/cm², the strength has a tendency to decrease.

Furthermore, when the elongation at breakage is less than 200%, breakage of the rubber is apt to be caused when

deformation of the tire is very large. When the elongation at breakage is more than 500%, the heat generation increases.

5 In general, aromatic polyamide fibre cords have a superior strength and a very low extensibility, but involve a problem that adhesion to the topping rubber is smaller when compared with nylon fibre cords and aliphatic polyamide fibre cords, which problem has obstructed their use.

10 In a heavy duty, high-speed radial tire for aircraft or the like, if the adhesion is less than 21.0 kgf/cm, a rubber separation might occur in a high-speed rotation under a heavy load and a large deformation, and thus, it cannot be adopted for such a use.

15 Table 1 shows a treating method (so called "double dipping") for a nylon or aliphatic polyamide fibre cord, by which the adhesion of the nylon or aliphatic polyamide fibre cord to the topping rubber is effectively improved. In the aromatic polyamide fibre cord, this method is ineffective, and adhesion more than 21.0 kgf/cm cannot be obtained.

20 However, it has been found that an effective method of treating the aromatic polyamide fibre cord, through which the adhesion to the topping rubber becomes the same level as nylon or aliphatic polyamide fibre cords, or more improved, and thereby it becomes possible to use aromatic polyamide fibre cords for the belt cord.

25 Table 2 shows this improved treating method, in which the aromatic polyamide fibre cord is treated by a 1st dipping process twice continuously, and then by a 2nd dipping process twice continuously.

30 Further, in this embodiment, for the carcass cords, the same aromatic polyamide fibre cord as the above-mentioned belt cord is used. However, a single material cord or a hybrid cord which is composed of plural materials, of which material or materials are extensible organic fibre, e.g., aromatic polyamide, nylon, polyester and the like; carbon fibre; and
35 metallic wires, e.g., steel, may be used. In each of the

carcass plies 7a and 7b, the carcass cords are embedded in the topping rubber.

Furthermore, the above-mentioned band plies 10a in this embodiment are formed by a cord winding method. That is, one or more cords are wound spirally and continuously from one tread edge TE to the other tread edge TE. By employing such a cord winding method, the hooping effect of the band is remarkably improved to increase the rigidity of the tread portion. Preferably, the cord thickness in each ply is varied so that the thickness is larger in the central part than the edge parts. Therefore, the central part of the tread portion in which the largest expansive force acts is strengthened more than the edge parts. As a result the strength of the tread portion is more uniform, and the tire weight can be reduced.

COMPARISON TESTS

According to the specifications shown in Table 3, belt cords for a 46 x 17R20 aircraft tire shown in Fig. 1 were made to compare their adhesions. The test results are shown in the same Table 3, wherein the adhesion of aromatic polyamide fibre cord A was increased 14% in comparison with aromatic polyamide fibre cord B, and demonstrated approximately equal adhesion to nylon fibre cord B.

Test tires which were aircraft tires of 46 x 17R20 size having a structure shown in Fig. 1 were made in order to test their durability, heat generation and resistance to high internal pressure. The specifications of the test tires are given in Table 4.

Durability Test: according to TSO-C62c, Technical Standard Order of the U.S. Federal Aviation Administration, a high-speed take-off cycle test and a taxi cycle test were made to evaluate the durability of each test tire. The total running distance of the tire until tire failure was occurred was measured as durability. The results are indicated by index in Table 4.

Heat Generation Test: applying a speed and a load corresponding to the normal service condition and using a tester, temperature was measured at the tread portion, sidewall portion and bead portion of each test tire.

5 Over Pressure Test: test tire was filled with water, and the water pressure was increased to cause tire failure. The results are shown in Table 4.

10 As described above, the belt cords are made of aromatic polyamide fibre which had the following characteristics: the twist coefficient (TN) is in the range of 2.466×10^3 to 3.036×10^3 , the elongation (E) at breakage divided by the total denier number (D) is in the range of 7.78×10^{-4} to 12.22×10^{-4} ; and the adhesion of the belt cord to the topping rubber is not less than 21.0 kgf/cm.

15 Therefore, the hooping effect of the belt structure of the tire of aspects of this connection is effectively improved, and the tire can withstand a high internal pressure. Further, as the belt structure of aspects of this invention is provided with a proper high extensibility, separation failure,
20 e.g., belt edge looseness can be prevented even under severe service conditions, e.g., high-speed and heavy load and high internal pressure. Accordingly, the tire of aspects of this invention is improved in structural durability, together with various performances, e.g., cornering performance.

25

TABLE 1

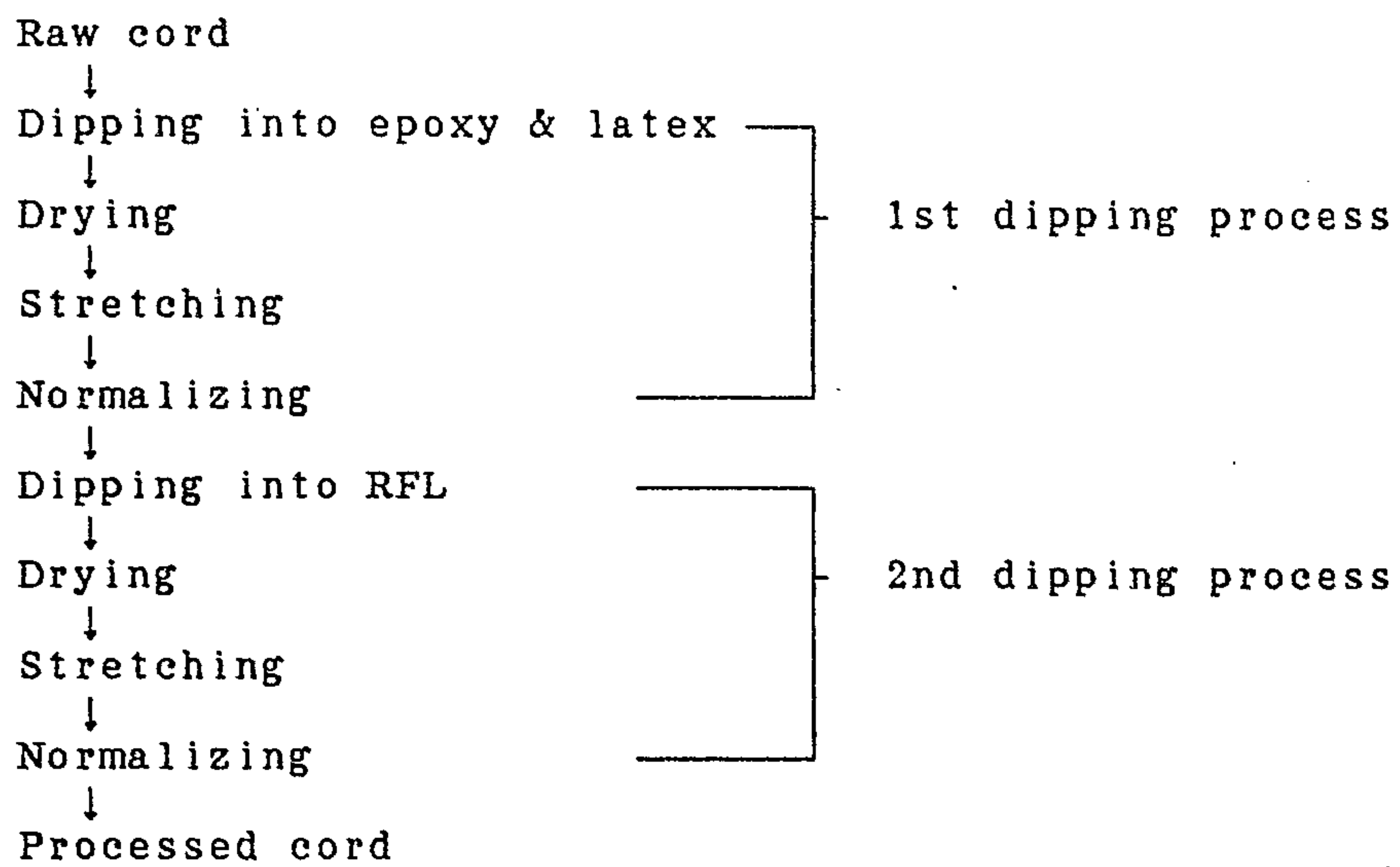


TABLE 2

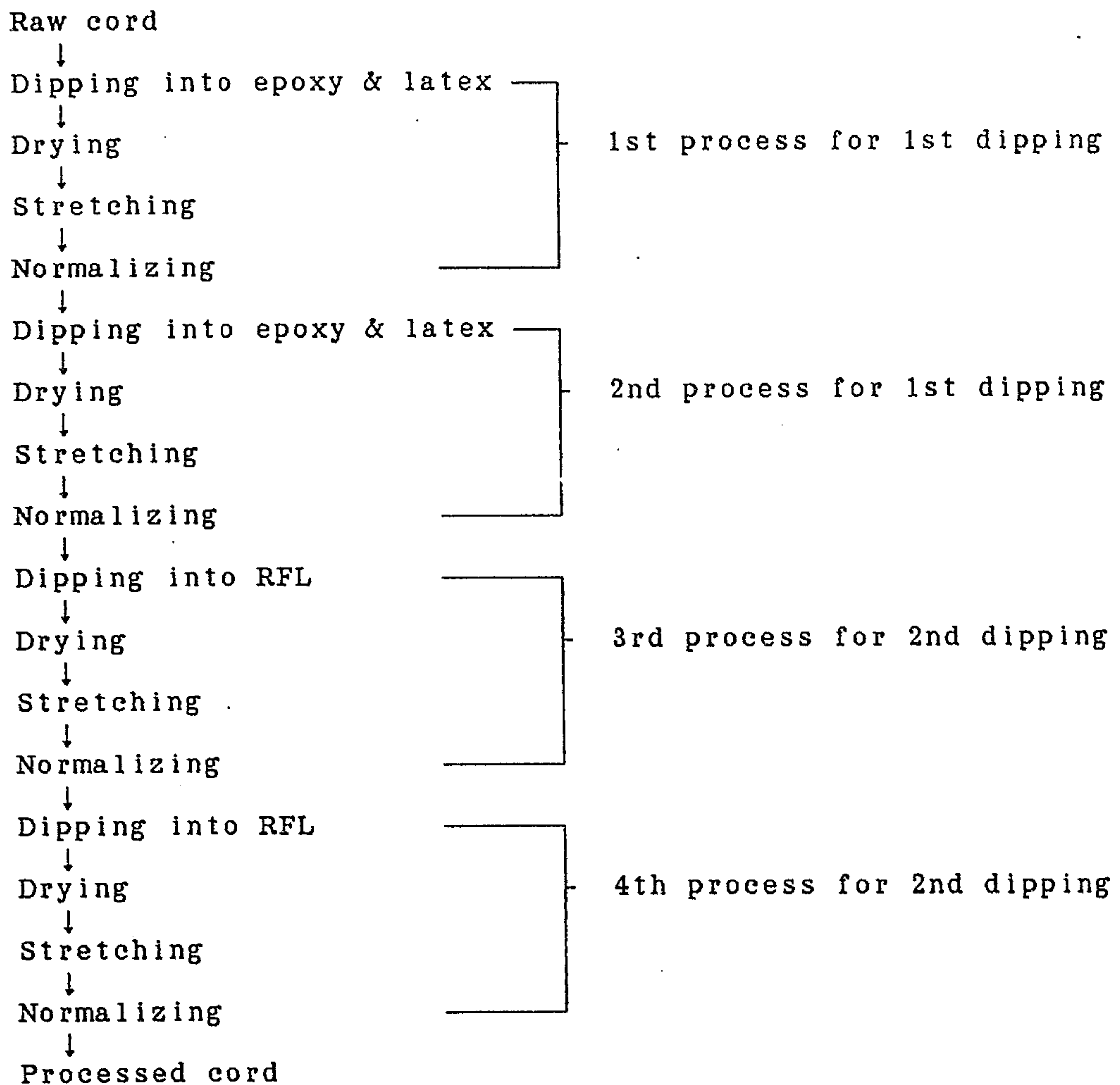


TABLE 3

Cord	A	B	C
Material	aromatic polyamide fibers (3000d/3)	nylon fibers (1890d/3)	aromatic polyamide fibers (3000d/3)
Total denier D	9000	5670	9000
Cable twist T (turns/10cm)	30	34	22
Twist coefficient $TN=T \cdot \sqrt{D}$	2.846×10^4	2.56×10^4	2.087×10^4
Strength (kgf)	129.0	48.0	150.0
Elongation at breakage E (%)	9.0	28.0	60
E/D	10×10^{-4}	49.38×10^{-4}	6.67×10^{-4}
Thickness d (mm)	1.29	1.05	1.25
Ends per 50 mm	33	42	33
Treating method	Table 2	Table 1	Table 1
Adhesion (kgf/cm)	23.8	24.5	20.9

TABLE 4

TIRE	Ex.1	Ref.1	Ref.2	Ref.3	Ref.4	Ref.5
CARCASS						
Inner layer	2 plies	4 plies	2 plies	2 plies	2 plies	2 plies
Outer layer	1 ply	2 ply	1 ply	1 ply	1 ply	1 ply
Cord material	aromatic polyamide fibers	nylon fibers	aromatic polyamide fibers	aromatic polyamide fibers	aromatic polyamide fibers	aromatic polyamide fibers
BAND						
Cord material	4 plies aromatic polyamide fibers	9 plies nylon fibers	3 plies aromatic polyamide fibers	3 plies aromatic polyamide fibers	8 plies nylon fibers	3 plies aromatic polyamide fibers
BREAKER						
Cord material	2 plies aromatic polyamide fibers	Absent	2 plies aromatic polyamide fibers	2 plies aromatic polyamide fibers	2 plies nylon fibers	2 plies aromatic polyamide fibers
PROTECTOR						
	Present	Present	Absent	Absent	Absent	Absent
Durability	200	200	10	70	20	20
Temperature (deg.)						
Tread part	89	80	96	91	85	67
Shoulder part	81	72	86	66	105	109
Bead part	65	70	111	100	104	94
Over-pressure Resistance (kgf/sq.cm)						
	81.0 (Belt ply broken)	67.5 (Side- wall broken)		40-60 (Belt ply broken)		
Tire weight (kg)	71.7	77.0	73.8	74.6	74.5	73.4

CLAIMS:

1. A heavy duty, high-speed radial tire comprising:

a pair of bead portions, each said bead portion having a bead core disposed therein; a carcass which is turned up around said bead cores and which is composed of at least one ply of carcass cords which are laid at angles in a range from 75 degrees to 90 degrees with respect to the tire equator, said carcass cords being aromatic polyamide fibre cords; and an aromatic polyamide fibre cord belt structure which is disposed radially outside the carcass and inside a rubber tread;

said belt structure comprising:

a breaker which is disposed radially outside said carcass and which is composed of at least one ply of said aromatic polyamide fibre belt cords which are laid at angles of from 10 to 30 degrees to the tire equator, and

a band which is disposed radially outside said breaker and which is composed of plurality of plies of at least one aromatic polyamide fibre belt cord which is wound spirally and continuously from one edge to other edge thereof to be laid at an angle of from 0 to 5 degrees to the tire equator,

further wherein: the product $T\sqrt{D}$ of the cable twist number (T) (turns/10 cm) of said belt cord and the square root of the total denier number (D) (deniers) of said belt cord, is in a range from 2.466×10^3 to 3.036×10^3 ;

the elongation (E) (in %) at breakage of said belt cord divided by the total denier number (D) of said belt cord, is in a range from 7.78×10^{-4} to 12.22×10^{-4} ,

the product $T\sqrt{D}$ of the cable twist number (T) of said carcass cord and the square root of the total denier number (D) of said carcass cord, is in a range from 2.466×10^3 to 3.036×10^3 ; and

the elongation (E) at breakage of said carcass cord divided by the total denier number (D) of the carcass cord, is in a range from 7.78×10^{-4} to 12.22×10^{-4} .

2. A heavy duty high-speed radial tire comprising: a carcass which is turned up around bead cores which are disposed one in each bead portion of the tire, and composed of at least one ply of cords laid at angles of no less than 75 degrees and no more than 90 degrees with respect to the tire equator; and

a belt which is disposed radially outside said carcass and inside a rubber tread, said belt comprising a band belt and a breaker belt which are disposed radially inside said band belt, said breaker belt being composed of a plurality of plies of breaker belt cords which are laid at angles of from 10 to 30 degrees to the tire equator so that said breaker belt cords in each ply cross the breaker belt cords in the adjacent ply, said band belt being composed of a plurality of band plies, said breaker belt cords and said at least one band belt cord comprising aromatic polyamide fibre cords, each satisfying the following conditions:

the twist coefficient (TN), the product $T\sqrt{D}$ of the cable twist (T) (turns/10 cm) of said cord and the square root of the total denier number (D) (deniers) of said cord, of each said belt cord being not less than 2.466×10^3 and not more than 3.036×10^3 ; and

the elongation (E) (in %) at breakage of each said belt cord divided by the total denier number (D) of the cord, being not less than 7.78×10^{-4} and not more than 12.22×10^{-4} ; and

further wherein: each said band ply is made of at least one band belt cord which is wound spirally and continuously from one edge to the other edge of said ply, so that the cord angle is in the range of from 0 to 5 degrees to the tire equator.

3. A heavy duty high-speed radial tire according to claim 1 or claim 2, wherein the thickness of the wound belt cord in each said band belt ply is larger at the tire equator than the edge parts of the ply.

4. A heavy duty high-speed radial tire according to claim 1 or claim 2, wherein the thickness of the wound belt cord in said band is larger at the tire equator than at the edge parts of the band.
5. A heavy duty high-speed radial tire according to any one or more of claims 1 to 4, inclusive, wherein said belt cords are rubberized with a topping rubber composition.
6. A heavy duty high-speed radial tire according to claim 5, wherein the 100% modulus of said topping rubber of said belt cord is in the range of 30 to 70 kgf/sq. cm.
7. A heavy duty high-speed radial tire according to claim 5, or claim 6, wherein the elongation at breakage of said topping rubber of said belt cord is in the range of 200 to 500%.
8. A heavy duty high-speed radial tire according to claim 5, claim 6 or claim 7, wherein the adhesion of the belt cord to said belt topping rubber is not less than 21.0 kgf/cm.
9. A heavy duty high-speed radial tire according to any one or more of claims 1 to 8, inclusive, wherein said carcass comprises an inner layer which is turned up around said bead cores from the inside to the outside of said tire, and an outer layer which is turned up around said bead cores from the outside to the inside of said tire so as to wrap the turned up portions of the inner layer.
10. A heavy duty high-speed radial tire according to claim 9, wherein said inner layer is composed of a plurality of plies and wherein said outer layer is composed of a plurality of plies.

