
(12) PATENT ABRIDGMENT (11) Document No. AU-B-25755/88
(19) AUSTRALIAN PATENT OFFICE (10) Acceptance No. 608095

(54) Title
HEAVY DUTY PNEUMATIC RADIAL TIRES

International Patent Classification(s)
(51)* **B60C 011/06 B60C 011/01**

(21) Application No. : **25755/88** (22) Application Date : **21.11.88**

(30) Priority Data

(31) Number	(32) Date	(33) Country
62-298036	25.11.87	JP JAPAN
63-266903	21.10.88	JP JAPAN

(43) Publication Date : **08.06.89**

(44) Publication Date of Accepted Application : **21.03.91**

(71) Applicant(s)
BRIDGESTONE CORPORATION

(72) inventor(s)
YASUTAKA ENOKI; SHIGEO MAKINO; SHINJI MURASE

(74) Attorney or Agent
GRIFFITH HACK & CO, GPO Box 1285K, MELBOURNE VIC 3001

(57) Claim

1. A heavy duty pneumatic radial tire comprising a tread composed of a tread portion for contacting the ground and provided with a plurality of circumferential main grooves, a fine groove having an opening width corresponding to 5-75% of the width of one of the main grooves and extending substantially continuously in the peripheral direction of the tire being arranged in at least one side face of said tread portion, and said fine groove in cross-section having a first segment and a second segment bent inwardly from said first segment such that centerlines of said first and second segments extend at different angles relative to the circumferential plane of said tire, said fine groove starting from a position corresponding to 0-150% of the depth of said main groove which is located inward from an effective ground contact end of said tread portion along an outer profile of said side face in the radial direction, and is bent inward from said ground contact end of said tread in the axial direction to a position to 0.5-10% of the ground contact width of said tread and inward from said ground contact end

.../2

(11) AU-B-25755/88
(10) 608095

-2-

of said tread in the radial direction to a position corresponding to 20-180% of the depth of said main groove.

3. The heavy duty pneumatic radial tire according to claim 1 or 2, wherein said fine groove has a groove wall portion which is covered with a rubber layer having excellent cracking resistance and ozone resistance at a thickness corresponding to a depth of at least 0.5mm measured from the groove wall surface.

608095

AUSTRALIA.

PATENTS ACT 1952

Form 10

COMPLETE SPECIFICATION

(ORIGINAL)

FOR OFFICE USE

Short Title:

Int. Cl:

Application Number:
Lodged:

Complete Specification-Lodged:
Accepted:
Lapsed:
Published:

Priority:

Related Art:

TO BE COMPLETED BY APPLICANT

Name of Applicant: BRIDGESTONE CORPORATION

Address of Applicant: 10-1 KYOBASHI 1-CHOME
CHUO-KU
TOKYO
JAPAN

Actual Inventor:

Address for Service: GRIFFITH HACK & CO.,
601 St. Kilda Road,
Melbourne, Victoria 3004,
Australia.

This document contains the
amendments made under
Section 49 and is correct for
printing

Complete Specification for the invention entitled:
HEAVY DUTY PNEUMATIC RADIAL TIRES

The following statement is a full description of this invention
including the best method of performing it known to me:-

HEAVY DUTY PNEUMATIC RADIAL TIRES

This invention relates to heavy duty pneumatic radial tires, and more particularly to a heavy duty pneumatic radial tire which effectively prevents the occurrence of uneven wear at shoulder ribs in a tread of
05 the tire.

As the conventional heavy duty pneumatic radial tire, there is, for example, a tire shown in Fig. 6. Such a heavy duty pneumatic radial tire 1 comprises a tread 2 contacting with ground, a belt 3 composed of
10 plural belt layers containing steel cords therein for the reinforcement of the tread 2, and a carcass 6 located inside the belt 3 and extending between a pair of bead cores 5.

In the tread 2 of the heavy duty pneumatic radial tire 1, both end portions 3a of the belt 3
15 reinforce both shoulder portions 2a of the tread 2, while the central portion 3b of the belt 3 reinforces the central portion 2b of the tread 2. However, the rigidity of the shoulder portion 2a in the tread 2 is
20 smaller than that of the central portion 2b. Furthermore, there is a dragging phenomenon based on the difference in the size between the central portion 2b and the shoulder portion 2a in the tread 2. Therefore,

as shown in Fig. 6, the shoulder portion 2a of the tread 2 is prematurely worn to generate a stepwisely uneven wear or a so-called shoulder wear. In some occasions, the outer surface of the shoulder portion 2a in the tread 2 is wavyly worn in the circumferential direction (not shown), which propagates toward the central portion of the tread to generate the uneven wear called as a wavy wear.

In order to prevent the occurrence of these uneven wears, there are proposed the increase of the rigidity in the island part 8 of the shoulder portion 2a of the tread 2, the enlargement of crown radius R of the tread 2, the arrangement of many sipes on full surface 8a of the island part 8 of the shoulder portion 2a in the axial direction, and the like.

Among these proposals for the prevention of uneven wear, the increase of the rigidity in the island part 8 of the shoulder portion 2a is attained by increasing the width in widthwise direction of the island part 8 of the shoulder portion 2a. In this case, the effect of preventing the shoulder wear is recognized to a certain extent, but when lateral force applied to the tread end 2c becomes severer, the worn portion having a width W_0 and a stepwise difference t_0 or a so-called edging wear 9 (see Fig. 6) is produced in the tread end 2c, which undesirably progresses into the

shoulder wear or wavy wear, so that the sufficient restraining effect is not obtained.

On the other hand, when the crown radius R of the tread 2 is made large in order to reduce the
05 difference in the radius between the shoulder portion 2a and the central portion 2b in the tread 2, the dragging of the shoulder portion 2a of the tread 2 is prevented during the running to prevent the occurrence of uneven wear. In this case, however, the ground contact
10 pressure in the central portion of the tread lowers to generate the uneven wear in the central portion.

Moreover, when many sipes are arranged on the full surface of the island part of the shoulder portion in the tread in the axial direction, if the tire is used
15 under severer use conditions, particularly a heavy load condition, a small block defined between the adjoining sipes is worn before and after the sipe in the rotational direction of the tire to cause a so-called heel and toe wear.

20 It is, therefore, an object of the invention to provide a heavy duty pneumatic radial tire having a specific tread form, particularly a specific form of both side regions of the tread which reduces the ground contact pressure and effectively prevent the occurrence
25 of uneven wear even under severer use conditions by arranging a peripheral fine groove opening to the side



According to the present invention there is provided a heavy duty pneumatic radial tire comprising; a tread composed of a tread portion for contacting the ground and provided with a plurality of circumferential main grooves, a fine groove having an opening width corresponding to 5-75% of the width of one of the main grooves and extending substantially continuously in the peripheral direction of the tire being arranged in at least one side face of said tread portion, and said fine groove in cross-section having a first segment and a second segment bent inwardly from said first segment such that centerlines of said first and second segments extend at different angles relative to the circumferential plane of said tire, said fine groove starting from a position corresponding to 0-150% of the depth of said main groove which is located inward from an effective ground contact end of said tread portion along an outer profile of said side face in the radial direction, and is bent inward from said ground contact end of said tread in the axial direction to a position to 0.5-10% of the ground contact width of said tread and inward from said ground contact end of said tread in the radial direction to a position corresponding to 20-180% of the depth of said main groove.



According to a second aspect of the invention,
there is the provision of a heavy duty pneumatic radial
tire comprising a tread composed of a tread portion
contacting with ground and provided with plural circum-
05 ferential main grooves, characterized in that a fine
groove having an opening of groove width corresponding
to 5-75% of the width of said main groove and substan-
tially continuously extending in the peripheral direc-
tion of the tire is arranged in at least one side face
10 of said tread portion, and said fine groove starts from
a position corresponding to 0-150% of the depth of said
main groove located inward from an effective ground
contact end of said tread portion along an outer profile
of said side face in the radial direction and curvedly
15 extends inward from said ground contact end in the axial
direction to a position corresponding to 0.5-10% of a
ground contact width of said tread and inward from said
ground contact end in the radial direction to a position
corresponding to 20-180% of the depth of said main
20 groove, and a groove wall portion of said fine groove is
covered with a rubber layer having excellent cracking
resistance and ozone resistance at a thickness corre-
sponding to a depth of at least 0.5 mm measured from the
groove wall surface.

25 In the preferred embodiment of the first and
second inventions, the fine groove has at least one bent

portion.

The reason why the groove wall portion of the fine groove is covered with the rubber layer having a particular thickness is due to the fact that as the
05 running distance of the heavy duty pneumatic radial tire according to the first invention largely increases, troubles such as ozone cracking, tearing or the like may be caused in the groove bottom and groove wall portion of the fine groove.

10 Further, it is preferable that the rubber layer is large in the content of antioxidant as compared with the tread rubber in the central portion of the tread.

The heavy duty pneumatic radial tires according to the first and second inventions are preferable to
15 satisfy the following: that is, the fine groove has a groove depth corresponding to 20-150%, preferably 60-100% of the depth of the main groove. Further, the bent portion of the fine groove is preferable to be a dogleg-like form in section in the depthwise direction
20 of the fine groove. Particularly, the bent portion of the fine groove has a dogleg-like form bending so as to focus each side of the fine groove into the central portion of the tire. Moreover, the fine groove consists of an upper groove portion and a lower groove portion
25 connecting thereto through a bent portion, wherein the length of the upper groove portion is approximately

equal to that of the lower groove portion.

The width of the opening in the fine groove is within a range of 5-75%, preferably 30-45%. When the opening width is less than 5%, the opposed groove wall portions of the fine groove contact with each other under a slight loading during the running and the reduction of ground contact pressure in the vicinity of the ground contact end is insufficient, while when it exceeds 75%, the movement of outer blocks in the radial direction becomes too large as compared with the fine groove and the cracking or other trouble occurs in the inside of the fine groove.

The starting position of the fine groove is a position corresponding to 0-150%, preferably 25-65% of the depth of the main groove located inward from an effective ground contact end of the tread portion along an outer profile of the side face in the radial direction. When the starting position does not reach 0% or the starting position of the fine groove is a tread portion of the tread contacting with ground, the tear trouble occurs, while when it exceeds 150%, the effect of reducing the ground contact pressure at both side end parts of the tread portion is insufficient.

Further, the fine groove extends inward from the ground contact end in the axial direction to a position corresponding to 0.5-10%, preferably 1.0-5.0% of a

ground contact width of the tread and inward from the ground contact end in the radial direction to a position corresponding to 20-180%, preferably 70-130% of the depth of the main groove. When the extending position
05 is less than 0.5% inward in the axial direction, the reduction of the ground contact pressure at both side end parts of the tread portion is insufficient, while when it exceeds 10%, the ground contact pressure of the tread shoulder portion lowers as a whole and the ground
10 contact pressure of the ground contact end becomes relatively high. On the other hand, when the extending position of the fine groove is less than 20% inward in the radial direction, the reduction of the ground contact pressure at both side end parts of the tread
15 portion is insufficient, while when it exceeds 180%, the rigidity of the tread shoulder portion lowers and the troubles such as tear and the like occur.

The reason why the fine groove has at least one bent portion is based on the fact that the presence of
20 the bent portion disperses strain concentrated in the bottom of the fine groove to prevent the occurrence of cracking and tearing in the groove bottom.

Further, the reason why the thickness of the rubber layer covering the groove wall face of the fine
25 groove is limited to at least 0.5 mm from the groove wall surface is due to the fact that when it is less

than 0.5 mm, the effect by the arrangement of the rubber layer is lost. Preferably, the thickness of the rubber layer is within a range of 0.5-5.0 mm. Since the rubber layer is applied to the side face of the tread portion
05 of the tread, the upper limit of the thickness is 5.0 mm from viewpoints of the improvement of the processability and the suppression of the production cost.

In the heavy duty pneumatic radial tire of the first invention, the peripheral fine groove opening to
10 the side face of the tread portion is arranged in the predetermined region at given groove width, groove depth and form, so that the rigidity and ground contact pressure at both side end parts of the tread portion lower. Therefore, the stress concentration in the
15 ground contact end is prevented and also the premature occurrence of edging wear is restrained to prevent the occurrence of uneven wear at the ground contact end.

In the heavy duty pneumatic radial tire of the second invention, the fine groove as defined in the
20 first invention is arranged in the tread portion of the tread and also the groove wall face of the fine groove is covered with the particular rubber layer having the specified thickness, so that even when the repetitive strain is applied to the groove wall face of the fine
25 groove as the running distance of the tire increases, there is caused no ozone crack or tear trouble.

The invention will be described with reference to the accompanying drawings, wherein:

Fig. 1 is a partially sectional view of a first embodiment of the heavy duty pneumatic radial tire
05 according to the first invention;

Fig. 2 is an enlargedly sectional view of a main part of Fig. 1;

Fig. 3 is a partially sectional view of a second embodiment of the heavy duty pneumatic radial tire
10 according to the first invention;

Fig. 4 is a partially sectional view of a third embodiment of the heavy duty pneumatic radial tire according to the second invention;

Fig. 5 is an enlargedly sectional view of a main
15 part of Fig. 4; and

Fig. 6 is a partially sectional view of the conventional tire.

In Fig. 1 is shown a first embodiment of the heavy duty pneumatic radial tire according to the first
20 invention, the construction of which will be described below.

In Fig. 1, numeral 11 is a heavy duty pneumatic radial tire having a tire size of 11R22.5 14PR, which is used on a rim of 8.25x22.5 under an internal pressure of
25 7.25 kg/cm². The tire 11 comprises a tread 12 having a tread portion 12a contacting with ground, a belt 13

reinforcing the tread 12 and composed of plural belt layers containing steel cords therein, and a carcass 14 located inside the belt 13 and extending between a pair of bead cores. The tread portion 12a of the tread 12 is
05 divided into five island portions 17 by four circumferential main grooves 16 in the axial direction of the tire. The effective ground contact width W_{12} of the tread is 208 mm, and the width W_{16} and depth D_{16} of the main groove 16 are 13.5 mm and 14.7 mm, respectively.

10 The tread 12 has a fine groove 18 having an opening 18a at each side face 12b of the tread portion 12a in the axial direction thereof and substantially continuously extending in the peripheral direction thereof, a main part of which is enlargedly shown in
15 Fig. 2. The width W_{18} of the opening 18a in the fine groove 18 is 4.5 mm, which is 33.3% of the width W_{16} of the main groove 16. The fine groove 18 starts from a position A of 4 mm i.e. a distance L_A corresponding to 27.2% of the depth D_{16} of the main groove 16 located
20 inward from an effective ground contact end 20 of the tread portion 12a in the tread 12 along an outer profile of the side face 12b in the radial direction. Further, the fine groove 18 consists of an upper groove segment 18A, a bent segment 18B and a lower groove segment 18C
25 in the section of the tire which extend inward in the axial direction and inward in the radial direction,

wherein the upper groove segment 18A and the lower groove segment 18C are bent in form of dogleg through the bent segment 18B. Moreover, the acute angle θ_1 between a center line N_{18A} of the upper groove segment 05 18A and a line I perpendicular to the rotating axis of the tire is 60° , while the acute angle θ_2 between a center line N_{18C} of the lower groove segment 18C and the line I perpendicular to the rotating axis of the tire is -15° (provided that the outside of the line I in 10 the axial direction is + and the inside of the line I in the axial direction is -). The angle of the bent segment 18B with respect to the line I gradually changes with the curvature of center line N_{18B} thereof.

In this case, it is preferable that the angle θ_1 15 is relatively large and the angle θ_2 is relatively small. Particularly, the angle θ_1 is within a range of $0-140^\circ$, preferably $35-80^\circ$, while the angle θ_2 is within a range of $+90^\circ \sim -90^\circ$, preferably $-20^\circ \sim +40^\circ$.

The fine groove 18 starts from the position A 20 and extends to a position of 5.5 mm or a distance B corresponding to 2.6% of the effective ground contact width W_{12} of the tread 12 located inward from the effective ground contact end 20 in the axial direction and to a position of 14.7 mm or a distance C corresponding to 100% of the depth D_{16} of the main groove 16 25 located inward from the effective ground contact end 20

in the radial direction.

The width W_{18} of the fine groove 18 gradually reduces from the opening width of 4.5 mm as the depth of the fine groove becomes deeper, and the minimum width
05 W_{18M} of the fine groove 18 is 2.0 mm above a bottom 18D thereof. The groove bottom 18D takes a flask form considering the cracking or the like.

The depth D_{18} of the fine groove 18 is a length extending from the opening to the groove bottom 18D
10 along center lines N_{18A} to N_{18C} of the fine groove 18, which is 13.5 mm and corresponds to 92% of the depth D_{16} of the main groove 16. Furthermore, the length of the upper groove segment 18A in the fine groove 18 is approximately equal to that of the lower groove segment
15 18C.

As shown in Fig. 1, a concave portion 22 extending peripherally of the tire may be arranged in the side face 12b of the tread 12 inward from the fine groove 18 in the radial direction.

20 In the illustrated tire, the fine groove 18 is arranged in each side end part 12c of the tread portion 12a during the running, so that the ground contact pressure at both side end parts reduces to prevent the stress concentration in the ground contact end 20 and
25 suppress the occurrence of uneven wear.

In Fig. 3 is shown a second embodiment of the

heavy duty pneumatic radial tire according to the first invention, which has the same construction as in the first embodiment except for the following point.

That is, in the tire 31, the fine groove 18 consists of the upper groove segment 18A and the lower groove segment 18C curvedly extending inward in the axial and radial directions so that the angle θ_1 between the center line N_{18A} of the upper groove segment 18A and the line I perpendicular to the rotating axis ($+60^\circ$) and the angle θ_2 between the center line N_{18C} of the lower groove segment 18C and the line I ($+18^\circ$) are outside of the line I in the axial direction.

In Figs. 4 and 5 is shown a third embodiment of the heavy duty pneumatic radial tire according to the second invention, which has the same construction as in the second embodiment except for the following point.

That is, in the tire 41, the groove wall portion 18F at the groove bottom 18D and the side wall 18E of the fine groove 18 is composed of a rubber layer 43 having a thickness D_{43} of 2 mm as measured from the groove wall surface. As shown in Figs. 4 and 5, the side face 12c of the tread portion 12a is also covered with the rubber layer 43, which is due to the restriction in the formation of the rubber layer. The rubber layer 43 contains an antioxidant for ozone resistance, an amount of which is larger than that contained in the

central portion of the tread 12.

In the illustrated tire 41, the groove wall portion 18F of the fine groove 18 is covered with the rubber layer 43, so that even when the groove bottom 18D and side wall 18E of the fine groove 18 are repeatedly subjected to bending as the running distance increases, there is caused no cracking through ozone, nor cracking and tear troubles due to bending fatigue.

Then, the effect of the invention will be described by using the following four test tires (Test Examples 1-3 and Comparative Example).

The tire used in Test Example 1 was the same as shown in Fig. 1, and the tire used in Test Example 2 was the same as shown in Fig. 3, and the tire used in Test Example 3 was the same as shown in Fig. 4, while the tire used in Comparative Example was a tire having no fine groove 18 and concave portion 22, which corresponded to the conventional tire shown in Fig. 6.

Each of these tires was mounted on a normal rim and inflated under a normal internal pressure, which was then mounted on a test vehicle and run on general road under a normal load over a distance of 200,000 km. In this case, the occurrence state of uneven wear in the tread and the occurrence state of crack or tear trouble on the surface of the fine groove were observed after the running over a distance of 100,000 km or 200,000 km.

Moreover, the occurrence state of uneven wear was evaluated by measuring the edging wear produced at the tread end as a width W_0 and a stepwise difference t_0 of the uneven wear as shown in Fig. 6.

05 The measured results are shown in the following Table 1, wherein the upper part of Table 1 shows the results after the running over a distance of 100,000 km and the lower part thereof shows the results after the running over a distance of 200,000 km.

10

15

20

25

Table 1

			Comparative Example	Test Example 1	Test Example 2	Test Example 3
			Conventional tire	First embodiment of Fig.1	Second embodiment of Fig.3	Third embodiment of Fig.4
After running over 100,000 km	Amount of uneven wear generated	width W_0 (mm)	1.0~3.5	zero (no edging)	zero (no edging)	zero (no edging)
		stepwise difference t_0 (mm)	2~3	zero (no stepwise difference)	zero (no stepwise difference)	zero (no stepwise difference)
	Trouble on surface of fine groove		-	none	none	none
After running over 200,000 km	Amount of uneven wear generated	width W_0 (mm)	1.8~4.2	zero (no edging)	zero (no edging)	zero (no edging)
		stepwise difference t_0 (mm)	5~6	zero (no stepwise difference)	zero (no stepwise difference)	zero (no stepwise difference)
	Trouble on surface of fine groove		-	presence	presence	none

As shown in Table 1, in the measurement after the running over 100,000 km, the uneven wear was generated at a width W_0 of 1.0-3.0 mm and a stepwise difference t_0 of 2-3 mm in the tire of Comparative

05 Example, while no uneven wear was generated in the tires of Test Examples 1-3 (each of the width W_0 and stepwise difference t_0 was zero). Further, the crack or tear trouble on the surface of the fine groove was not observed in the tires of Test Examples 1-3. On the

10 other hand, in the measurement after the running over 200,000 km, the uneven wear in the tire of Comparative Example had a width W_0 of 1.8-4.2 mm and a stepwise difference t_0 of 5-6 mm, while the occurrence of uneven wear was not observed in the tires of Test Examples 1-3.

15 Moreover, the crack or tear trouble on the surface of the fine groove was observed in the tires of Test Examples 1 and 2, but it was not observed in the tire of Test Example 3.

As mentioned above, according to the first

20 invention, the peripheral fine groove opening to the side face of the tread portion in the tread is arranged on the particular region of the side face in a particular form, so that the ground contact pressure is reduced at the tread end part and the occurrence of

25 uneven wear at both end parts of the tread can effectively be prevented even under severer use conditions.

Further, according to the second invention, even when the running distance is increased, the occurrence of ozone cracking and tear troubles on the surface of the fine groove can be prevented in addition to the
05 effect of the first invention.

10

15

20

25

THE CLAIMS DEFINING THE INVENTION ARE AS FOLLOWS:

1. A heavy duty pneumatic radial tire comprising a tread composed of a tread portion for contacting the ground and provided with a plurality of circumferential main grooves, a fine groove having an opening width corresponding to 5-75% of the width of one of the main grooves and extending substantially continuously in the peripheral direction of the tire being arranged in at least one side face of said tread portion, and said fine groove in cross-section having a first segment and a second segment bent inwardly from said first segment such that centerlines of said first and second segments extend at different angles relative to the circumferential plane of said tire, said fine groove starting from a position corresponding to 0-150% of the depth of said main groove which is located inward from an effective ground contact end of said tread portion along an outer profile of said side face in the radial direction, and is bent inward from said ground contact end of said tread in the axial direction to a position to 0.5-10% of the ground contact width of said tread and inward from said ground contact end of said tread in the radial direction to a position corresponding to 20-180% of the depth of said main groove.

2. The heavy duty pneumatic radial tire according to claim 1, wherein said second segment of said fine groove has at least one curved portion.

3. The heavy duty pneumatic radial tire according to claim 1 or 2, wherein said fine groove has a groove wall portion which is covered with a rubber layer having excellent cracking resistance and ozone resistance at a thickness corresponding to a depth of at least 0.5mm measured from the groove wall surface.



4. A heavy duty pneumatic radial tire as hereinbefore described with reference to any one of the accompanying drawings.

5. A heavy duty pneumatic radial tire as hereinbefore described with reference to any one of the foregoing examples.

DATED THIS 17TH DAY OF DECEMBER 1990

BRIDGESTONE CORPORATION

By its Patent Attorneys:

GRIFFITH HACK & CO.

Fellows Institute of Patent
Attorneys of Australia



FIG. 2

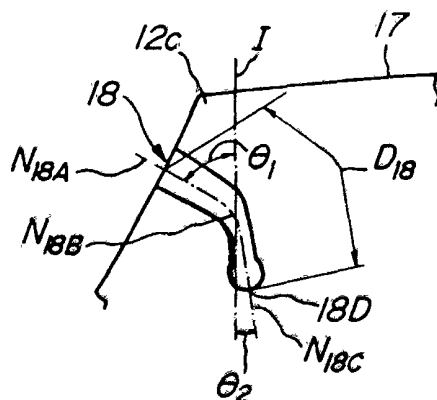
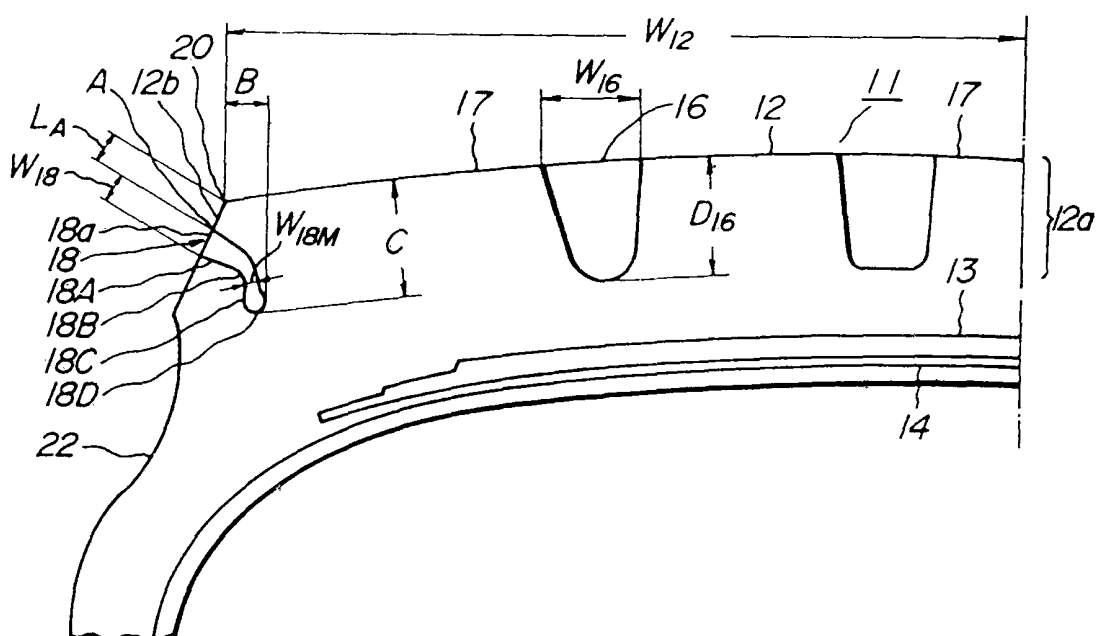


FIG. 3

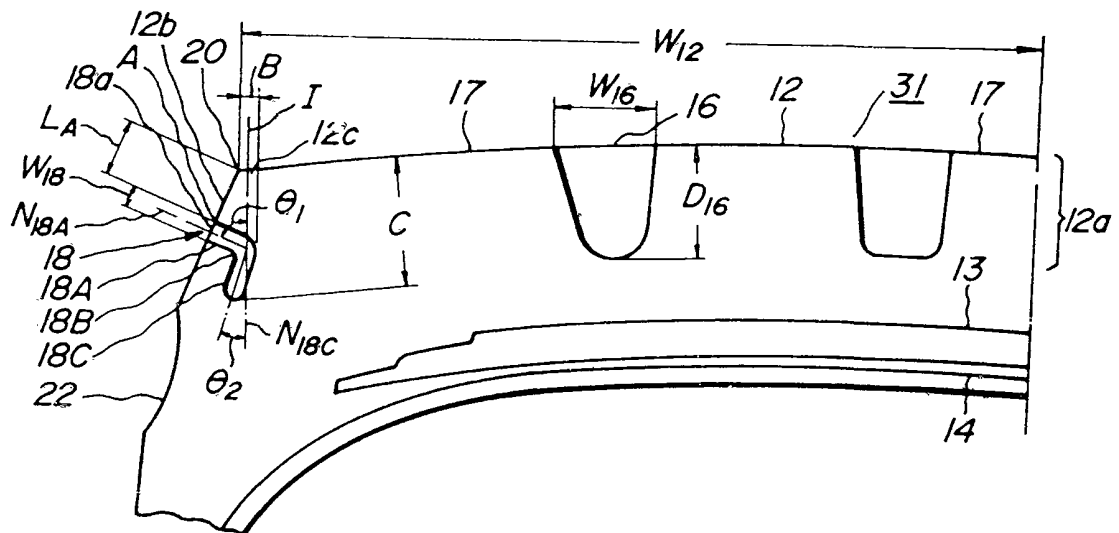


FIG. 4

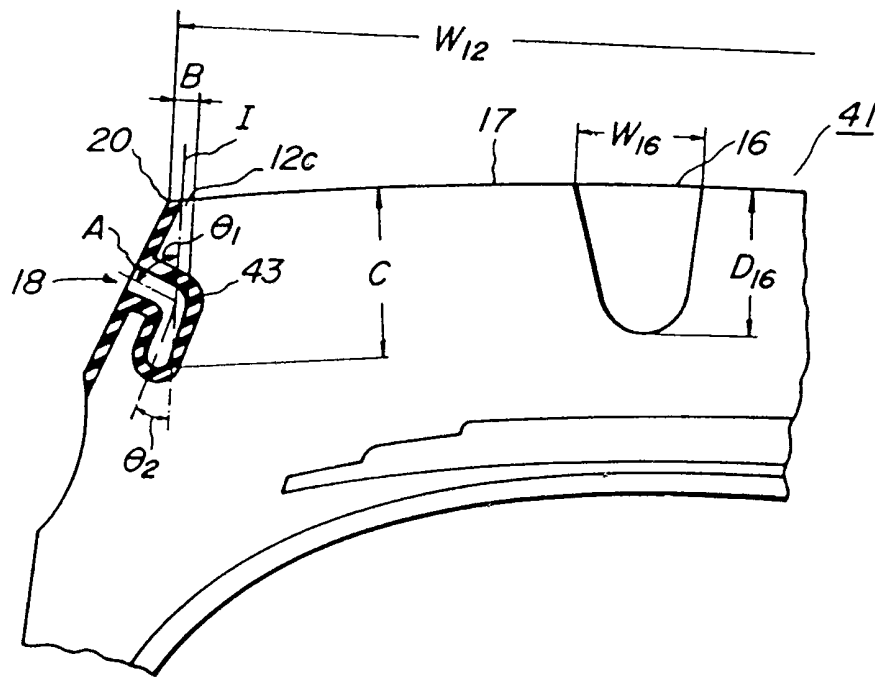
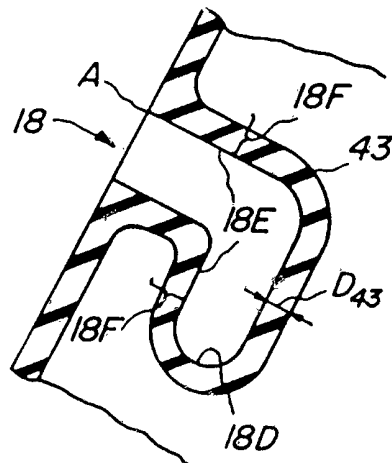


FIG. 5



PRIOR ART

