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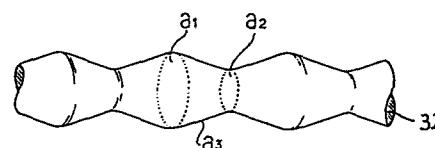
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⑤④ **Steel bar for concrete constructions.**

⑤⑦ The invention refers to a deformed steel bar (32, 33, 40, 50) for concrete constructions. To improve the adhesion between the steel bar and the concrete the steel bar has a longitudinal sectional profile which varies alternately and smoothly with a peak (a₁, 3A, 51) and a valley (a₂, 52) in the axial direction thereof.



SPECIFICATION

Title of the Invention

Steel Bar for Concrete Constructions

Background of the Invention

Field of the Invention

The present invention relates to steel bars used for concrete constructions. More particularly, the present invention relates to deformed steel bars buried in concrete.

Description of related art

With the aim of reinforcing concrete, a concrete structure constructed with structural steels and concrete has been used in every sort of constructions.

Ideal concrete constructions are such that structural steel and concrete are closely adhered to each other and react to an external force as a whole. Therefore, it is important that adhesive strength between the structural steel and the concrete is sufficiently high. In order to strengthen the adhesion between structural steel and concrete, deformed steel bars are often used as structural steel.

Deformed steel bars used so far have been round steels which have, on the surface, different patterns of projections or hollows. An example of such deformed bars is shown in

Figure 1A. As can be seen from the Figure 1A, a conventional deformed bar 10 is composed of a round steel 1, two ribs 2 extended parallel to the axis of the round steel 1 on radially opposite sides of the axis, and a plurality of nodes 3 alternately installed on each side of the round steel 1 separated by the ribs 2 in the direction perpendicular to the axis. Figure 1B is a cross-sectional view of the deformed bar shown in Figure 1A along a cutting line A-A.

As for configuration, a deformed steel bar shown in Figure 2 has been used as well. In Figure 2, a deformed bar 20 is characterized in that nodes 3 are provided as intersecting diagonally the axis of the deformed bar 20.

By using these deformed bars, adhesion between structural steels and concrete is strengthened. High adhesion strength between structural steel and concrete leads to advantages of concrete constructions such as: superposition length and fixing length of structural steels can be shortened; and, reliability against corrosion is improved because width of cracks in concrete is restricted to a small degree.

Figure 3 is a longitudinal sectional view of a concrete construction 30 in which a deformed bar 10 of the prior art as shown in Figure 1 is buried. As is apparent from the figure, adhesion of the deformed bar 10 to surrounding concrete 5 is obtained only through limited surface portions: ribs 2 and nodes 3. Other surface portions parallel to the

axis of the deformed bar 10, that is, a parallel part 4, do not contribute to adhesion. When repeated loads are applied to the concrete construction 30, cracks 7 and 7A are induced in the concrete in the vicinity of nodes 3 and destroyed layer 6 is formed around the deformed bar 10. Therefore, in concrete constructions including such deformed bars, cracks risk to develop rapidly, which results in a deterioration in resistivity of the concrete construction.

As described above, proper advantages of the deformed steel bars cannot be fully profited. In case of planning a construction using a concrete member in which the deformed steel bars are buried, the above-mentioned drawbacks must be taken into consideration. In other words, underestimated value for adhesive strength of the deformed steel bar to concrete should be adopted in planning.

Summary of the Invention

Accordingly, an object of the present invention is to provide a deformed bar of a specific shape capable of resolving the above-mentioned problems of the deformed steel bars of the prior art.

Considering that, in concrete constructions in which deformed bars of the prior art are used, cracks are induced only in limited area such as at ribs and nodes, and that destroyed layer is formed around the deformed bar, the inventors thought of a deformed bar of a specific shape that

the stress caused by repeated loads can be dispersed over a wide area.

Accordingly, the above and other objects of the present invention are achieved in accordance with the present invention by a steel bar for concrete constructions, of which the longitudinal sectional profile varies alternately and smoothly with a peak and a valley in the axial direction thereof.

Preferably, the ridgeline of the profile between the peak and the valley does not include discrete step. According to an embodiment of the present invention, each ridgeline of the peak portion draws a closed circle around the steel bar. In more detail, the equivalent diameter of the cross section of the valley portion perpendicular to the axis of steel bar is smaller than the equivalent diameter of the cross section of the peak portion perpendicular to the axis, and profile of the steel bar varies continuously through a smooth curved surface.

The deformed bar described above of the present invention can, for example, be manufactured by hot rolling a round steel with a kaliber rolls. However, the manufacturing thereof is not ristricted to the rolling method. The cross section of the deformed bar is preferably circular or polygonal such as a nearly circular hexagon. Other shapes are also possible, for example an oval. "Equivalent diameter" in this specification means the diameter of a

circle having the same cross-sectional area as the cross section in question.

According to a first embodiment of the present invention, equivalent diameter of the deformed bar at the peak portion, that is, the equivalent diameter corresponding to the maximum cross sectional area, is preferably between 8 and 55mm. In addition, the ratio of the equivalent diameter of the peak portion to that of the valley portion is preferably between 1.05 and 1.5. Deformed steel bars with the ratio over 1.5 are difficult to mass-produce. Further, such a large ratio is unnecessary for improving the adhesion strength between the deformed bar and concrete. What is worse, there is a risk of inducing locally ununiform and concentrated shear stress. On the other hand, deformed steel bars whose ratio of equivalent diameters is lower than 1.05 have almost even surface, which is no longer considered as deformed bars. Therefore, adhesion strength between deformed bars and concrete is not sufficient. The angle between the ridgelines drawn by the sectional profile in the direction of the axis of the deformed bar is over 90 degrees, preferably over 120 degrees at the peak portion.

According to a second embodiment of the present invention, ridgelines drawn by the peak portion extends in a spiral form around the steel bar. Average equivalent diameter is between 8 and 55mm, and the ratio of the radius the peak portion to that of the valley portion is between

1.05 and 1.5, just the same as in the first embodiment of the present invention.

As described above, deformed bars according to the present invention have an axial profile varying with peak and valley portions through a nearly continuous curved surfaces. Therefore, the deformed bar of the present invention does not include the parallel part 4 as seen in the deformed bar of the prior art.

The deformed bars of the present invention, not including projecting ribs nor nodes, does not induce concentrated shear stress to the surrounding concrete when the deformed bars are buried in a concrete construction. As will be described later referring to the attached drawings, when repeated loads are applied to the concrete construction, almost uniformly compressive stress is generated around the deformed bar of the present invention. As a result, the possibility of occurrence of cracking is remarkably reduced.

Accordingly, when the deformed bars of the present invention are buried in a concrete construction, uniform adhesion can be obtained along the whole length and all around the bar, and surrounding concrete is surely adhered to the bar. Even when external repeated loads are applied to the concrete construction, local shear stress does not appear and the external force acts as compressive force. Therefore, the destroyed layer is not formed around the deformed bars, which leads to a perfect integration between the bar and

concrete.

The above and other objects, features and advantages of the present invention will be apparent from the following description of preferred embodiments of the invention with reference to the accompanying drawings.

Brief Description of the Drawings

Figure 1A is a plane view of a deformed bar of the prior art;

Figure 1B is a cross-sectional view of the deformed bar shown in Figure 1A along a cutting line A-A;

Figure 2 is another plane view of a deformed bar of the prior art;

Figure 3 shows cracks in a concrete construction in which a deformed bar according to the prior art is buried;

Figure 4 is a perspective view of an embodiment of the deformed bar according to the present invention;

Figure 5A is a plane view of another embodiment of the deformed bar according to the present invention;

Figure 5B is a cross-sectional view of the deformed bar shown in Figure 5A along a cutting line B-B;

Figure 6 is a schematic longitudinal sectional view showing the state of load and shear force in a concrete construction in which a deformed bar of the prior art is buried;

Figure 7 is a schematic longitudinal sectional view

showing the state of load and shear force in a concrete construction in which a deformed bar of the present invention is buried; and

Figures 8 and 9 are respectively perspective views of other embodiments of the deformed bars according to the present invention.

Description of the Preferred Embodiments

Figure 4 is a perspective view of an embodiment of a deformed bar 32 according to the present invention. The deformed bar includes large sections a_1 with a large diameter and small sections a_2 with a small diameter alternately. The periphery of these sections are connected through a smooth curved surface a_3 .

The deformed bar of the present example shown in Figure 4 is manufactured by hot rolling a round bar with kaliber rolls. Therefore, the periphery of the large section a_1 and the small section a_2 are smoothly formed. The cross section perpendicular to the axis of the deformed bar is always in the form of a circle in this embodiment. However, deformed bars of arbitrary shapes including oval and hexagon may be used.

Figure 5A is a side view of another embodiment of a deformed bar 33 according to the present invention. Figure 5B is a cross-sectional view of the deformed bar shown in Figure 5A along the cutting line B-B.

The deformed bar shown in Figures 5A and 5B is composed of a plurality of truncated cones a_4 , each truncated cone having the bottom section a_1 with the first diameter and the top section a_2 with the second diameter.

More particularly, the plurality of truncated cones a_4 are disposed in an inverse direction to each other, that is, the adjacent truncated cones contact top to top or bottom to bottom along the common axis of rotation of each truncated cone.

Figure 6 is a schematic longitudinal sectional view showing the state of load and shear stress in a concrete construction in which a deformed bar of the prior art is buried.

In a concrete construction 30 including a deformed bar of the prior art, nodes 3 for maintaining good adhesion between the bar and the concrete will cause local shear stress 11, 12 in response to repeated loads applied to the concrete construction 30. The shear stress gives rise to cracks around the nodes 3. As a result, destroyed layers are formed in the concrete around the deformed bar.

Figure 7 is a schematic longitudinal sectional view showing the state of load and shear stress in a concrete construction in which a deformed bar of the present invention is buried.

Steel bar 40 does not comprise a member corresponding to ribs of the deformed bar of the prior art. Peak portions 3A

correspond to nodes 3 of the deformed bar of the prior art. Peripheral surfaces 15, 16 are uniformly formed at both sides of the peak portion 3A along the whole length of the steel bar 40. Furthermore, there is no corresponding to the parallel part 4 of the deformed bar of the prior art. Therefore, even if repeated loads are applied to the concrete construction, the loads are not concentrated at the peak portion 3A which corresponds to the nodes 3 of the deformed bar of the prior art, but are applied uniformly to the peripheral surfaces 15, 16. Thus, a stress from the deformed bar to the concrete acts as a compressive force 13, 14 acting from the peripheral surface 15,16 of the deformed bar. Namely, no local shear stress is acted.

Figures 8 and 9 are perspective views of other embodiments of the deformed bar according to the present invention. In these embodiments, steel bar 50 is in the shape of screw. Neither peak portion 51 nor valley portion 52 includes portion parallel to the axis of the steel bar 50. Adjacent peak and valley portions are formed through a peripheral surface 53. As can be seen in Figures 8 and 9, steel bars of left screw and right screw are equally utilizable.

When these deformed bars are used in a concrete construction, even if repeated loads are applied to the concrete construction, the loads are not concentrated to the peak portion 51 which corresponds to the nodes 3 of the

deformed bar of the prior art, but are applied uniformly to the large peripheral surface 53 between the peak and the valley portions. Therefore, stress from the deformed bar to the concrete acts as a compressive force from the peripheral surface of the deformed bar. As a result, uniform adhesion can be realized between deformed bar and concrete just as with the deformed bar shown in Figures 4 and 5.

As explained above, the deformed bar of the present invention buried in concrete has no ribs which are the cause of a local shear stress acting on the concrete under repeated loads. Therefore, the repeated loads are dispersed and the stress from the deformed bar to the concrete acts in the compressive direction. With the deformed bar of the present invention, such a concrete construction can be realized as: while adhesion is remarkably improved, destroyed layer is not formed.

In summary, the deformed bar of the present invention, whose adhesion to concrete is remarkably improved, has the following advantages:

- 1) Cross-sectional area of a concrete member can be greatly reduced because a large adhesion force is obtainable in design.

- 2) Occurrence of cracking is greatly suppressed: if cracks break out, the width of the cracking is kept small.

- 3) Integration as a structural member is well maintained and fatigue strength is improved highly because

destroyed layer is not formed between deformed bars and concrete.

The deformed bar of the present invention is, therefore, valuable for reinforced concrete constructions as well as for prestressed concrete constructions.

The invention has thus been shown and described with reference to specific embodiments. However, it should be noted that the invention is in no way limited to the details of the illustrated structures but changes and modifications may be made within the scope of the appended claims.

Claims

1. A steel bar (32, 33, 40, 50) for concrete constructions, said steel bar (32, 33, 40, 50) being characterized in that the longitudinal sectional profile thereof varies alternately and smoothly with a peak (a_1 , 3A, 51) and a valley (a_2 , 52) in the axial direction thereof.
2. A steel bar for concrete constructions as claimed in claim 1, wherein the ridgeline of said longitudinal sectional profile does not include discrete step.
3. A steel bar for concrete constructions as claimed in claim 2, wherein each ridgeline of the peak portions (a_1 , 3A) draws a closed circle around the axial direction.
4. A steel bar for concrete constructions as claimed in claim 3, wherein the equivalent diameter of the cross section of the valley portion (a_2) perpendicular to the axis of the steel bar (32, 33, 40) is smaller than the equivalent diameter of the cross section of the peak portion (a_1 , 3A) perpendicular to the axis, and the profile of the steel bar (32, 33, 40) varies continuously through a smooth curved surface.
5. A steel bar for concrete constructions as claimed in claim 4, wherein the cross section perpendicular to the axis is nearly in the form of a circle.
6. A steel bar for concrete constructions as claimed in claim 5, wherein the equivalent diameter of the cross section of the peak portion (a_1 , 3A) is between 8 and 55 mm, and the ratio of the equivalent diameter of the peak portion (a_1 , 3A) to that of the valley portion (a_2) is between 1.05 and 1.5.

7. A steel bar for concrete constructions as claimed in claim 2, wherein the ridgeline of the peak portion (51) is in the form of a spiral around the steel bar (50).
8. A steel bar for concrete constructions as claimed in claim 7, wherein average equivalent diameter of the steel bar (50) is between 8 and 55 mm, and the ratio of the radius of the peak portion (51) from the axis of the steel bar (50) to that of the valley portion (52) is between 1.05 and 1.5.
9. A steel bar for concrete constructions as claimed in claim 1, wherein the equivalent diameter of the cross section of the valley portion (a_2 , 52) perpendicular to the axis of the steel bar (32, 33, 40, 50) is smaller than the equivalent diameter of the cross section of the peak portion (a_1 , 3A, 51) perpendicular to the axis, and the profile of the steel bar varies continuously through a smooth curved surface (a_3 , a_4 , 15, 16, 53).
10. A steel bar for concrete constructions as claimed in claim 9, wherein the cross section perpendicular to the axis is nearly in the form of a circle.
11. A steel bar for concrete constructions as claimed in claim 10, wherein the equivalent diameter of the cross section of the peak portion (a_1 , 3A, 51) is between 8 and 55 mm, and the ratio of the equivalent diameter of the peak portion (a_1 , 3A, 51) to that of the valley portion (a_2 , 52) is between 1.05 and 1.5.

FIGURE 1A
PRIOR ART

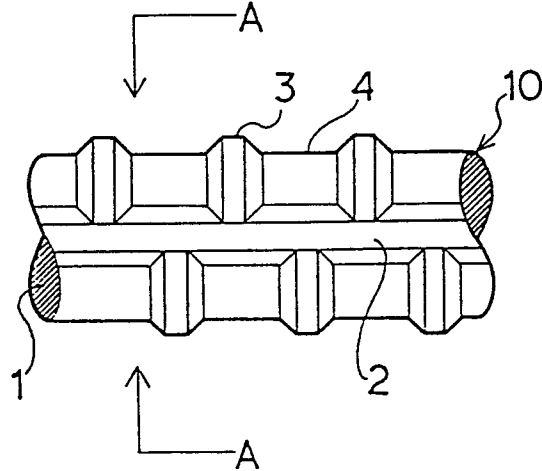


FIGURE 1B
PRIOR ART

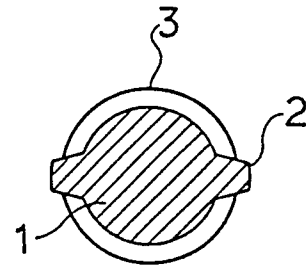


FIGURE 2 **PRIOR ART**

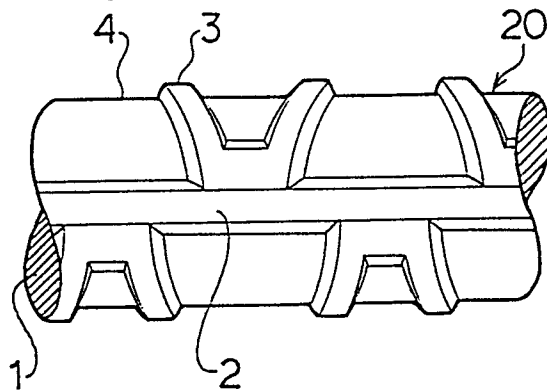


FIGURE 3 **PRIOR ART**

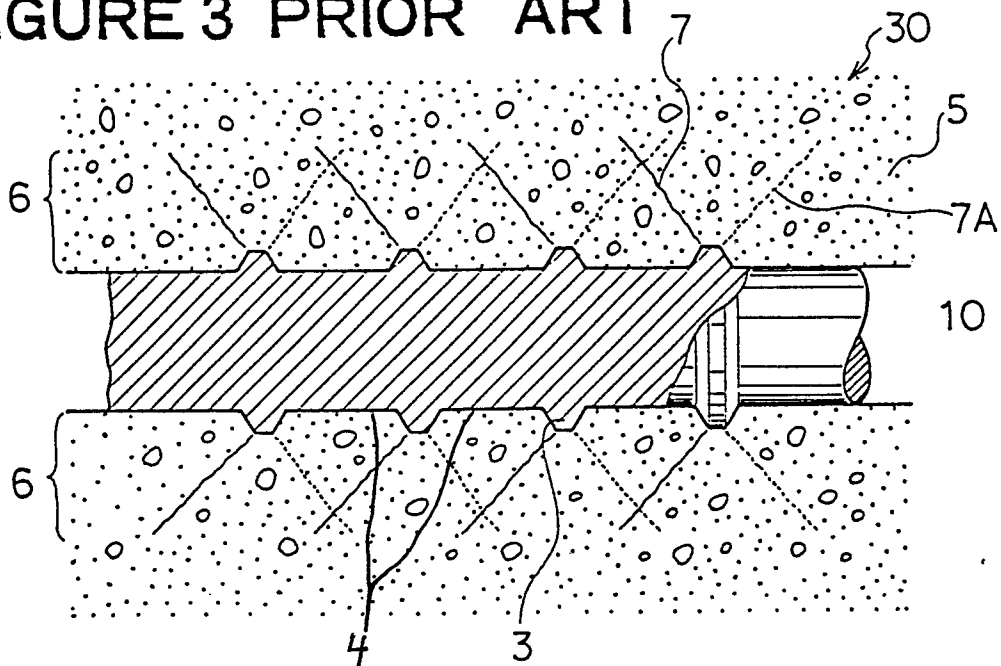


FIGURE 4

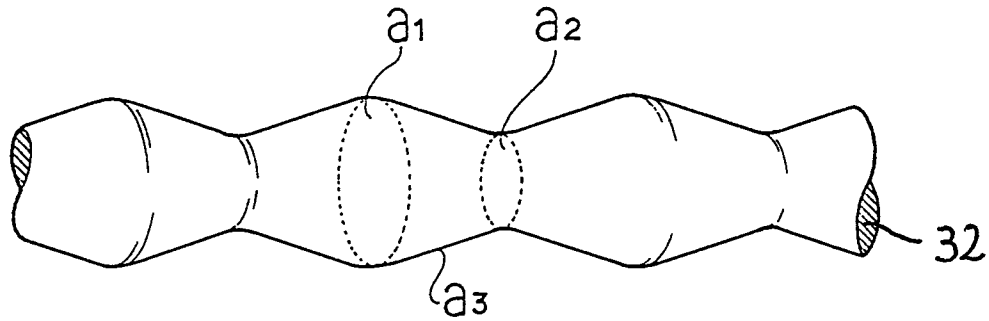


FIGURE 5A

FIGURE 5B

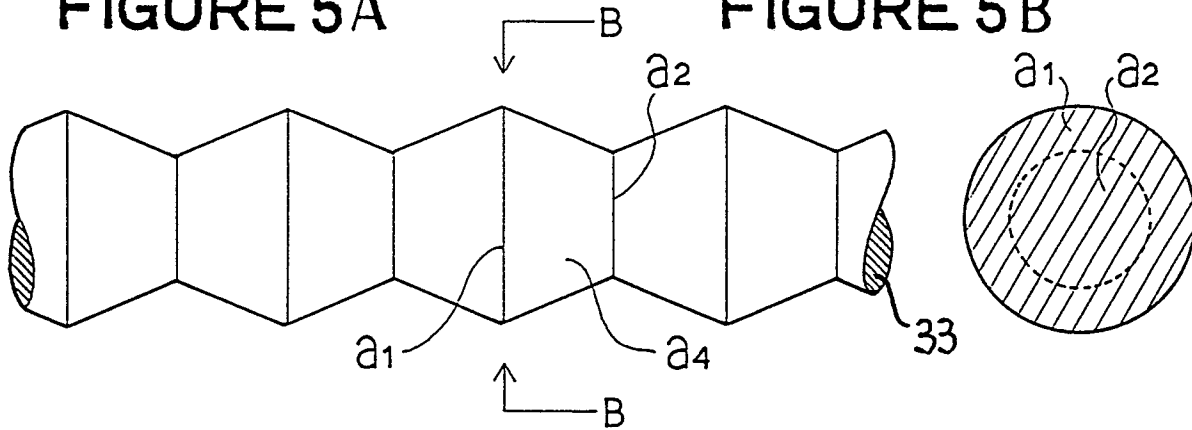
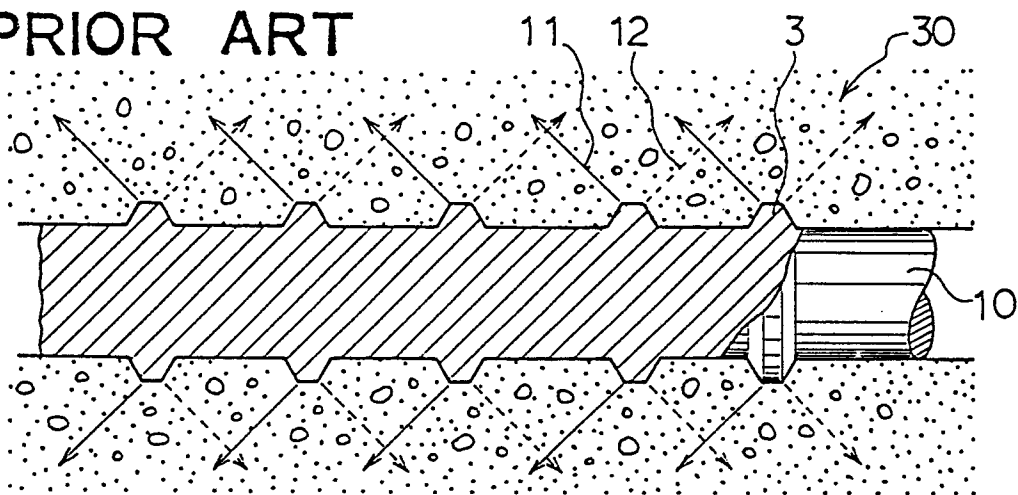
FIGURE 6
PRIOR ART

FIGURE 7

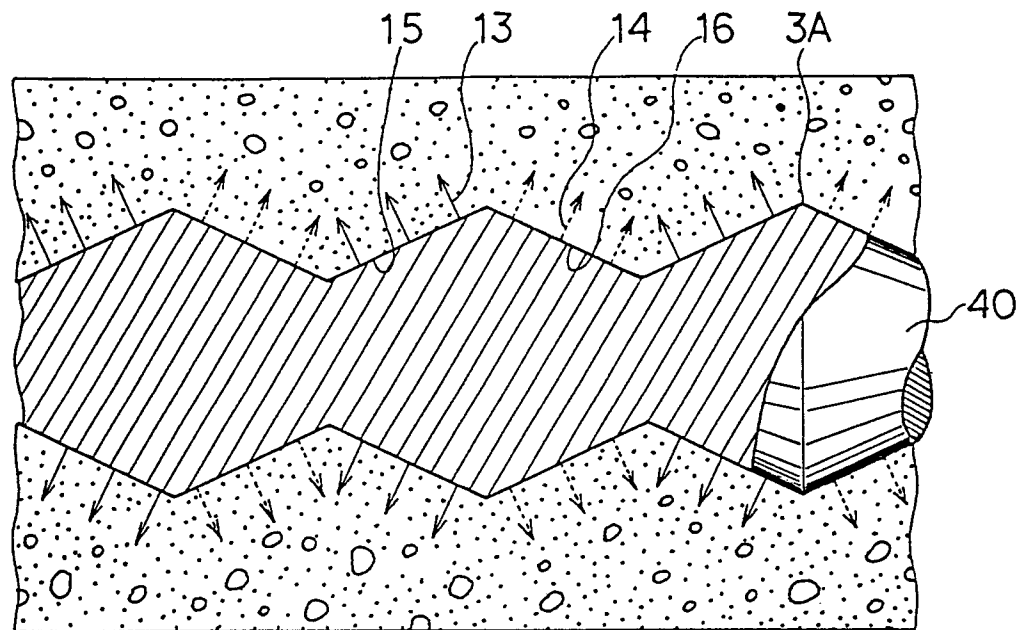


FIGURE 8

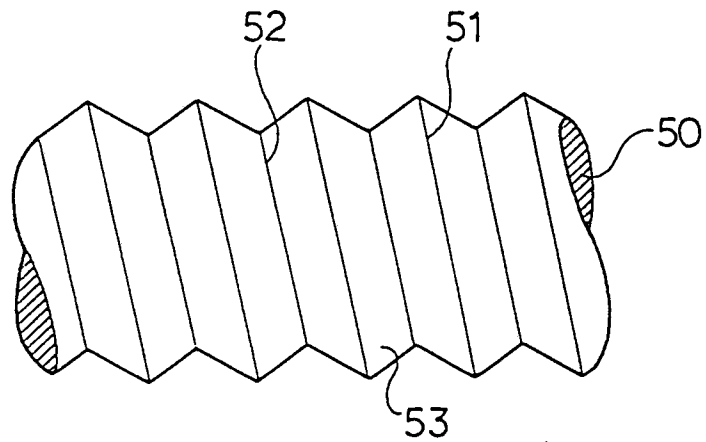


FIGURE 9

