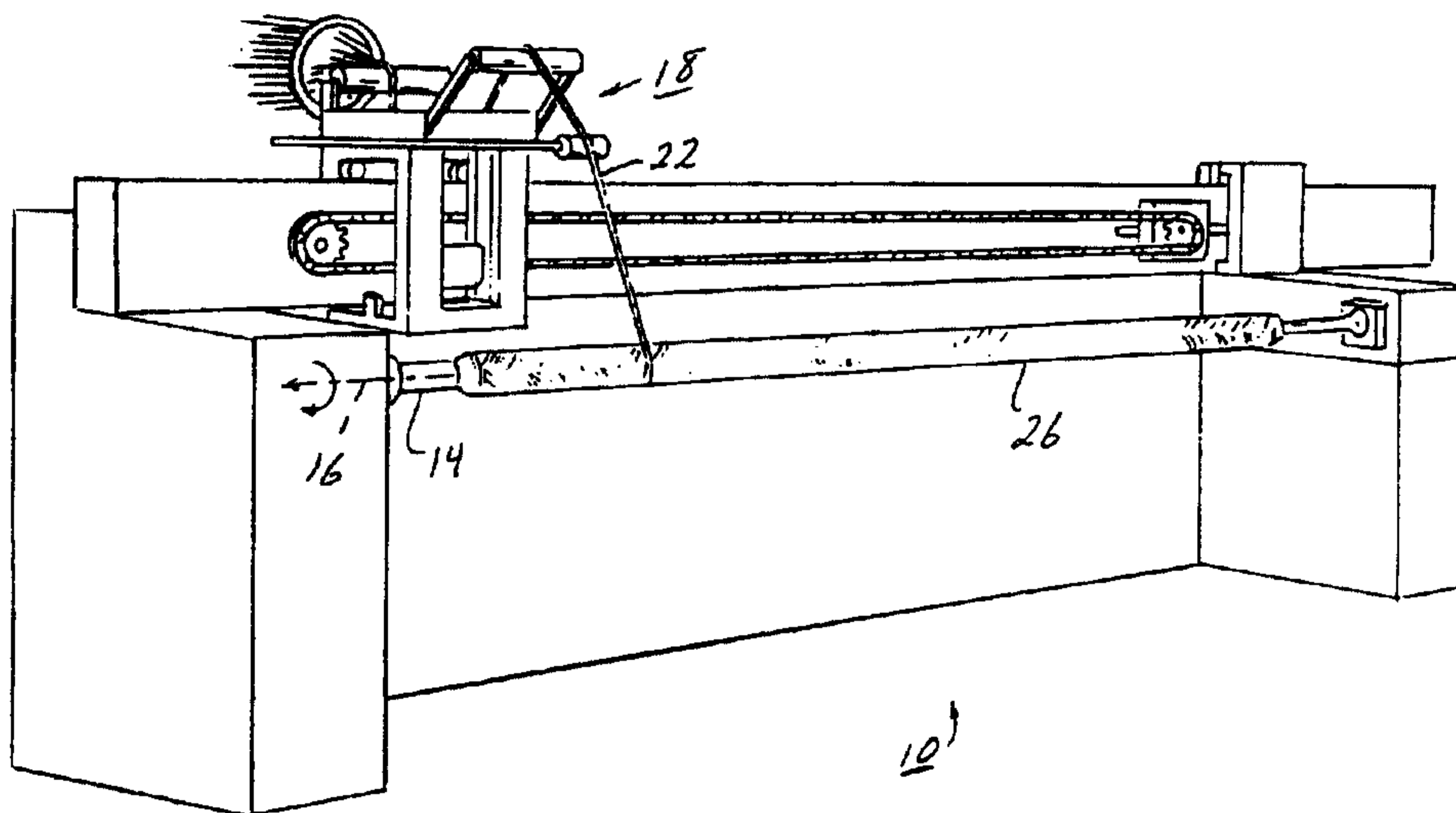




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(51) Int.Cl.⁶ B29C 70/32
(30) 1998/01/08 (09/004,459) US
(54) **METHODE DE FABRICATION D'UN ECRAN POUR Puits
RENFORCE AU MOYEN DE FIBRES**
(54) **METHOD OF MANUFACTURING A FIBER-REINFORCED
WELL SCREEN**



(57) A method for manufacturing a fiber-reinforced well screen, the method comprising the steps of winding a fiberglass strand onto a cylindrical mandrel to form a pipe around the mandrel, the fiberglass strand having a thickness and a winding angle, and the fiberglass strand being impregnated with a thermosetting resin having a composition, and creating openings in the pipe by varying at least one of the strand thickness, the winding angle, and the resin composition, the method being performed without removing material from the pipe after the winding step.



ABSTRACT OF THE DISCLOSURE

5 A method for manufacturing a fiber-reinforced well
screen, the method comprising the steps of winding a
fiberglass strand onto a cylindrical mandrel to form a
pipe around the mandrel, the fiberglass strand having a
thickness and a winding angle, and the fiberglass
strand being impregnated with a thermosetting resin
having a composition, and creating openings in the pipe
10 by varying at least one of the strand thickness, the
winding angle, and the resin composition, the method
being performed without removing material from the pipe
after the winding step.

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**METHOD OF MANUFACTURING A
FIBER-REINFORCED WELL SCREEN**

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BACKGROUND OF THE INVENTION

The invention relates to methods of manufacturing pipe, and particularly, to a method of manufacturing fiber-reinforced well screens.

U.S. Patent No. 3,864,182 discloses a method of making a fiber-reinforced well screen. The method involves placing an elongated coiled strip on a mandrel and forming slots in the strip, filling the slots with resin-impregnated fibers to form a fiber-reinforced tube having the strip embedded therein, removing the tube and embedded strip from the mandrel, and removing the strip from the interior of the tube. Removal of the strip from the tube leaves radially extending openings in the tube.

U.S. Patent No. 3,879,243 discloses another method for making a fiber-reinforced well screen. The method involves winding resin-impregnated fibers along with a matrix material around a mandrel. The matrix material is removed from the resultant pipe by suitable means such as application of heat, a solvent or a vacuum. Removal of the matrix material leaves openings in the pipe. Patent No. 3,897,243 teaches that the bandwidth of the filamentary material and the matrix material may be altered by changing the winding angle during the winding process so as to provide variable size openings in the wall of the pipe.

It is also known to make a well screen by manufacturing a conventional fiber-reinforced plastic pipe and then machining the pipe to form openings.

SUMMARY OF THE INVENTION

The invention provides a method that is an improvement over the above-described methods and other

known methods for manufacturing fiber-reinforced plastic well screens. A disadvantage of the methods of Patent Nos. 3,864,182 and 3,879,243 is that material other than resin-impregnated fiber is employed and then removed after winding. This increases both the cost of and time necessary for manufacturing the well screen. Also, it can be very difficult to remove the matrix material of Patent No. 3,879,243.

According to the invention, a fiber-reinforced well screen is manufactured by winding fiber strands at a given winding angle onto a mandrel to form a pipe around the mandrel. The mandrel is preferably cylindrical, and the fiber strands are preferably fiberglass. A layer of the fiber strands is wound onto the mandrel in a pattern that creates a pattern of openings or voids where the fiber strands do not cover the mandrel. As successive layers of fiber strands are wound onto the mandrel, positioning of the successive layers directly on top of the preceding layer extends the openings or voids in a radial direction relative to the axis of rotation of the mandrel to create a cylindrical screen or filter having radially extending flow channels.

In another embodiment, the successive layers of fiber strands are offset from the preceding layers in order to extend the openings or voids in a helical direction relative to the axis of rotation of the mandrel to create a cylindrical screen or filter having helical flow channels. Helical flow channels generally decrease turbidity of the fluid flowing through the filter.

In still another embodiment, the thickness of the fiber strands, the winding angle of the fiber strands or the composition of the resin can be varied to vary the size or cross-sectional area, as well as the cross-sectional shape of the flow channels. The thickness of the fiber strands, the winding angle of the fiber strands or the composition of the resin can be varied individually or together in any combination depending upon the circumstances. The method is preferably performed without removing material from the pipe after

winding, such as the strip of U.S. Patent No. 3,864,182 or the matrix material of U.S. Patent No. 3,879,243.

Other features and advantages of the invention will become apparent to those skilled in the art upon review of the following detailed description, claims and drawings.

DESCRIPTION OF THE DRAWINGS

Fig. 1 is a perspective view of an apparatus for performing the method of the invention.

Fig. 2 is a partial perspective view of a well screen manufactured according to the method of the invention.

Fig. 3 is a partial sectional view of a well screen manufactured according to the method of the invention.

Fig. 4 is an enlarged partial view of a well screen manufactured according to the method of the invention and using a winding angle of approximately forty-five degrees (45°) as measured from the axis of rotation of the mandrel.

Fig. 5 is an enlarged partial view similar to Fig. 4 wherein the well screen is manufactured using a winding angle of greater than forty-five degrees (45°) as measured from the axis of rotation of the mandrel.

Fig. 6 is an enlarged partial view similar to Fig. 4 wherein the well screen is manufactured using a winding angle of less than forty-five degrees (45°) as measured from the axis of rotation of the mandrel.

Fig. 7 is a schematic representation of a sectional view of a well screen taken along line 7-7 in Fig. 4. In Fig. 7, the layers of fiber are offset from one another by a predetermined amount to vary the shape of the opening.

Fig. 8 is a sectional view taken along line 8-8 in Fig. 7.

Fig. 9 is a sectional view taken along line 9-9 in Fig. 7.

Fig. 10 is a view similar to Fig. 9, but for a well screen wherein the layers of fiber are stacked without any offset to produce radial openings. Fig. 10

differs from Fig. 9 also in that the cross-section is taken in a plane that is perpendicular to the axis of rotation of the mandrel.

Before one embodiment of the invention is explained in detail, it is to be understood that the invention is not limited in its application to the details of the construction and the arrangements of components set forth in the following description or illustrated in the drawings. The invention is capable of other embodiments and of being practiced or being carried out in various ways. Also, it is to be understood that the phraseology and terminology used herein is for the purpose of description and should not be regarded as limiting.

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DESCRIPTION OF THE PREFERRED EMBODIMENT

An apparatus 10 for performing the method of the invention is illustrated in Fig. 1. The apparatus 10 is preferably substantially identical to the apparatus disclosed in U.S. Patent No. 3,499,815, which is incorporated herein by reference. The apparatus 10 includes a cylindrical mandrel 14 mounted for rotation about an axis 16, and a device 18 which forms a fiber strand or bundle 22 of fiberglass or another suitable fiber, impregnates the fiber strand 22 with thermosetting resin, and winds the resin-impregnated fiber strand 22 onto the mandrel 14 as the mandrel rotates about the axis 16. The apparatus 10 is well known in the art and need not be described in greater detail.

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As shown in Fig. 1, the fiber strand 22 is wound around the mandrel 14 to create a pipe 26 formed from the patterned layer of fiber strand 22 on the mandrel 14. As best shown in Figs. 3 and 7, the pipe 26 includes an inner surface 30, an outer surface 34, and a plurality of openings, passageways or flow channels 38 extending between the inner and outer surfaces, 30 and 34, respectively.

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Fig. 10 is a partial cross-section of a well screen manufactured according to one embodiment of the method such that a series of layers of fiber strand 22

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are wound onto the mandrel 14 in a given pattern that creates the openings 38 where there is no fiber strand covering the mandrel 14. In the embodiment shown in Fig. 10, the fiber strand 22 is continuously wound
5 around the mandrel 14 in successive layers using the same pattern so that the successive layers are positioned directly on top of the preceding layer (i.e., the layers are not offset from one another) in order to form flow channels 38 that extend radially
10 outward with respect to the axis of rotation of the mandrel 14.

Figs. 2, 3, and 7-9 illustrate a well screen 38 manufactured using another embodiment of the method wherein the fiber strand 22 is continuously wound
15 around the mandrel 14 in successive layers using the same pattern as the preceding layers. However, in the embodiment illustrated in Figs. 2, 3, and 7-9, the successive layers are slightly offset from the preceding layers. In this manner, flow channels 38 are
20 formed that extend helically outward (rather than radially outward) with respect to the axis of rotation of the mandrel 14. The offset of successive patterns is best shown in Fig. 8, which is a partial cross-section of the well screen 26 taken along line 8-8 in
25 Fig. 7. The openings 38 cannot be seen in their entirety in Fig. 8 because of the helical nature of the openings relative to the axis 16.

Figs. 7 and 9 illustrate in detail a well screen made from the method described above and having the
30 helically outwardly extending flow channels 38. The helical flow channels 38 reduce the turbidity of the fluid flowing through the filter.

In either of the embodiments discussed above, the cross-sectional size and shape of the flow channels 38
35 can be varied by varying at least one of the winding angle of the apparatus, the thickness of the fiber strand 22, the placement of the fiber strand 22, or the composition of the resin impregnating the fiber strand 22. The pattern offset, winding angle, fiber strand
40 thickness, fiber strand placement, and viscosity of the resin can be varied alone or in combination with any of

the other parameters to achieve the desired results.

Figs. 4, 5, and 6 illustrate the effect of a change in the winding angle on the size and shape of the flow channels 38. For example, the winding angle can theoretically vary between one degree (1°), as measured from the axis 16, and eighty-nine degrees (89°). However, in practice, the winding angle is preferably between forty degrees (40°) and sixty degrees (60°). As shown in Fig. 4, the winding angle is approximately forty-five degrees (45°) from the axis 16 and the resulting cross-sectional shape of the flow channel 38 is nearly a square. In Fig. 5, the winding angle is greater than forty-five degrees (45°) and, as a result, the pipe 26 shown in Fig. 5 has diamond-shaped openings 40 having minor axes 42 that are generally parallel to the mandrel axis 16. In contrast, in Fig. 6, the winding angle is less than forty-five degrees (45°) and, as a result, the pipe 26 shown in Fig. 5 has diamond-shaped openings 44 having major axes 46 that are generally parallel to the mandrel axis 16.

Additionally, the strand thickness can vary between .001 inch and .125 inch or more, and the viscosity of the resin, while preferably about 500 centipoise, can vary between approximately 300 and approximately 1000 centipoise. Preferably, the resin is a thermosetting resin, such as epoxy, polyester or vinylester although other resin compositions can be used when certain viscosities and winding temperatures are maintained. Also, the strand thickness, the winding angle and the resin composition are preferably varied in a linearly repetitive manner, so that the openings 30 have a repetitive pattern.

After completion of the winding process, the pipe 26 is removed from the mandrel 14 by sliding the pipe 26 off of the mandrel 14. The result is a fiber-reinforced well screen, which is partially illustrated in Figs. 2 and 3. It is not necessary to remove any material from the well screen 26 before use as a well screen. When removed from the mandrel 14, the well screen 26 has therein many openings 38

-7-

extending between the inner and outer surfaces 30 and 34, respectively, of the well screen 26.

Various features of the invention are set forth in the following claims.

CLAIMS

1. A method of manufacturing a pipe having a sidewall and openings in the sidewall, said method comprising:
5 winding a fiber strand onto a mandrel to form a pipe around the mandrel, the fiber strand being impregnated with a resin having a composition; and
creating openings in the pipe by varying said
10 composition.
2. A method as set forth in Claim 1 wherein said winding step includes winding the fiber strand around a cylindrical mandrel.
15
3. A method as set forth in Claim 1 wherein said step of creating openings is performed without removing material from the pipe after said winding step.
4. A method as set forth in Claim 1 wherein the fiber strand also has a strand thickness, and wherein said creating step also includes varying the strand thickness.
20
5. A method as set forth in Claim 1 wherein the fiber strand is wound around the mandrel at a winding angle, and wherein said creating step includes varying the winding angle.
25
6. A method as set forth in Claim 1 wherein said creating step includes varying the resin composition on a linearly repetitive basis.
30

7. A method for manufacturing a pipe having a sidewall and openings in the sidewall, said method comprising:

winding around a mandrel, at a given winding
5 angle, a resin-impregnated fiber strand having a
thickness so as to form a pipe having a sidewall; and
creating openings in said sidewall by varying at
least one of the strand thickness and the winding
angle, and without removing material from said sidewall
10 after said winding step.

8. A method as set forth in Claim 7 wherein said
winding step includes winding the fiber strand around a
cylindrical mandrel.
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9. A method as set forth in Claim 7 wherein said
creating step includes varying both the strand
thickness and the winding angle.

20 10. A method as set forth in Claim 8 wherein the
fiber strand is impregnated with a resin having a
composition, and wherein said creating step includes
varying the resin composition.

25 11. A method as set forth in Claim 7 wherein said
creating step includes varying the strand thickness.

12. A method as set forth in Claim 11 wherein
said creating step includes varying the strand
30 thickness on a linearly repetitive basis.

13. A method as set forth in Claim 7 wherein said
creating step includes varying the winding angle.

35 14. A method as set forth in Claim 7 wherein said
creating step includes varying the winding angle on a
linearly repetitive basis.

15. A method for manufacturing a fiber-reinforced well screen, said method comprising:

winding a fiberglass strand around a cylindrical mandrel at a given angle to form a pipe having a sidewall, the fiberglass strand having a thickness and being impregnated with a thermosetting resin having a composition; and

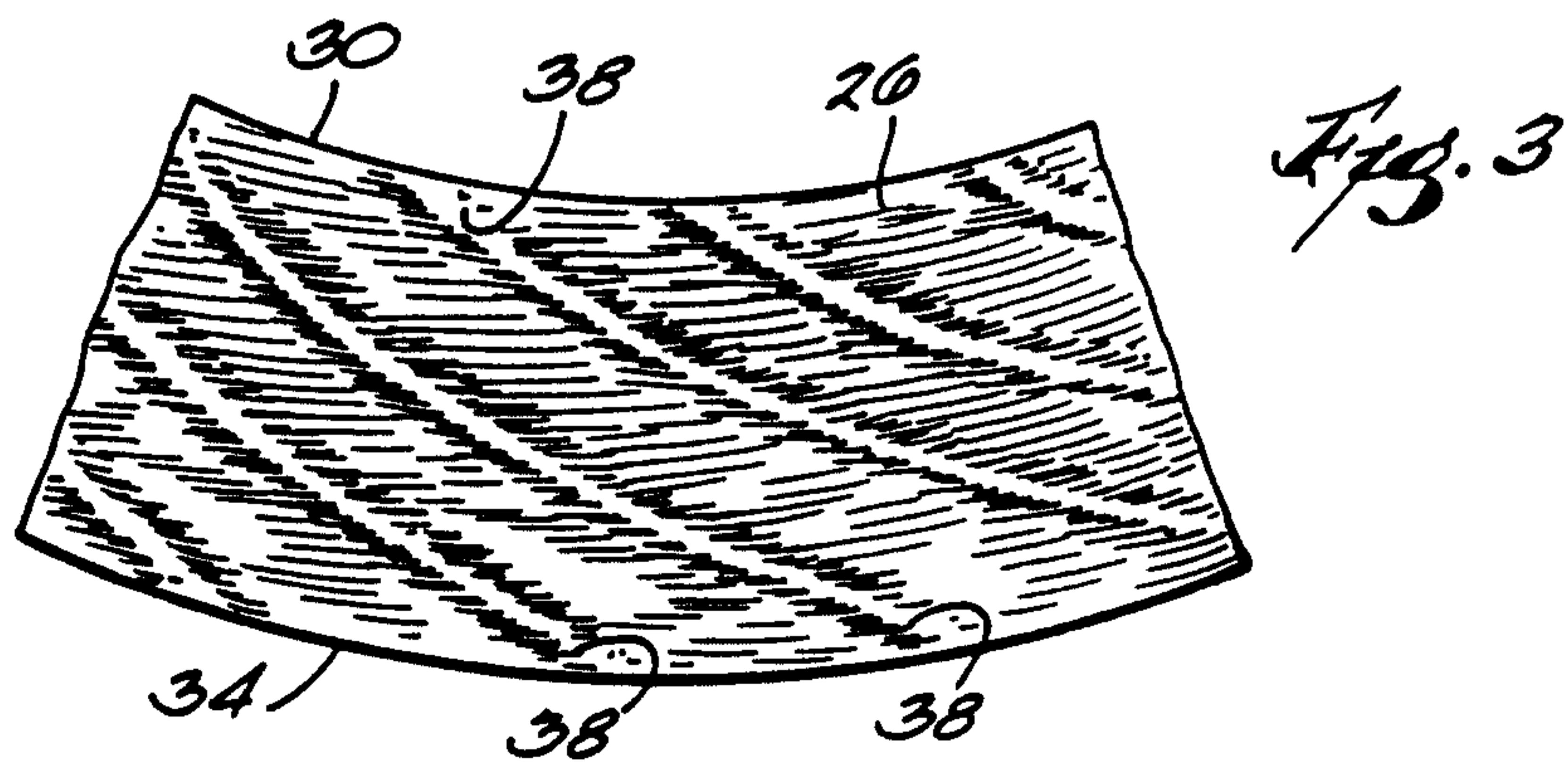
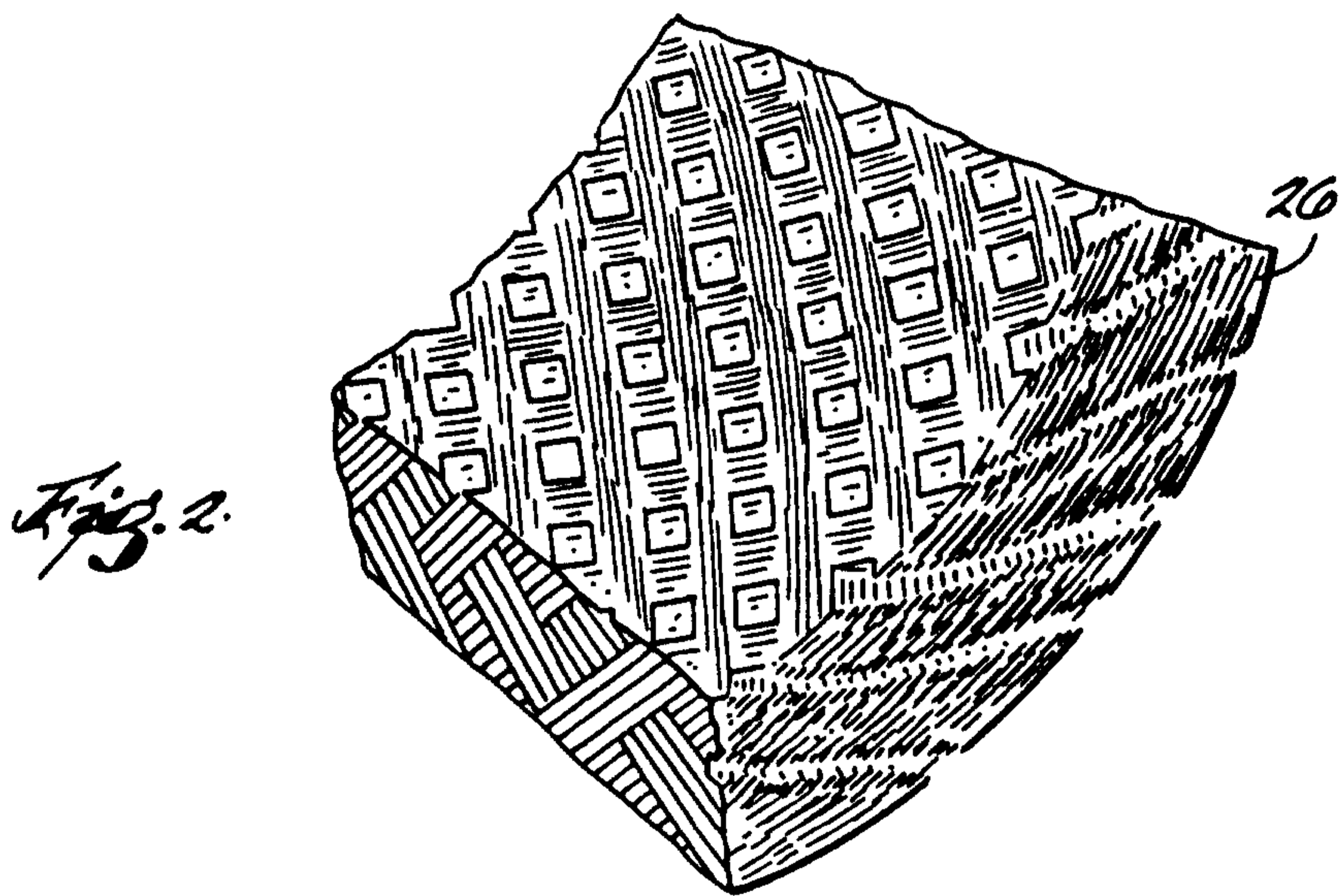
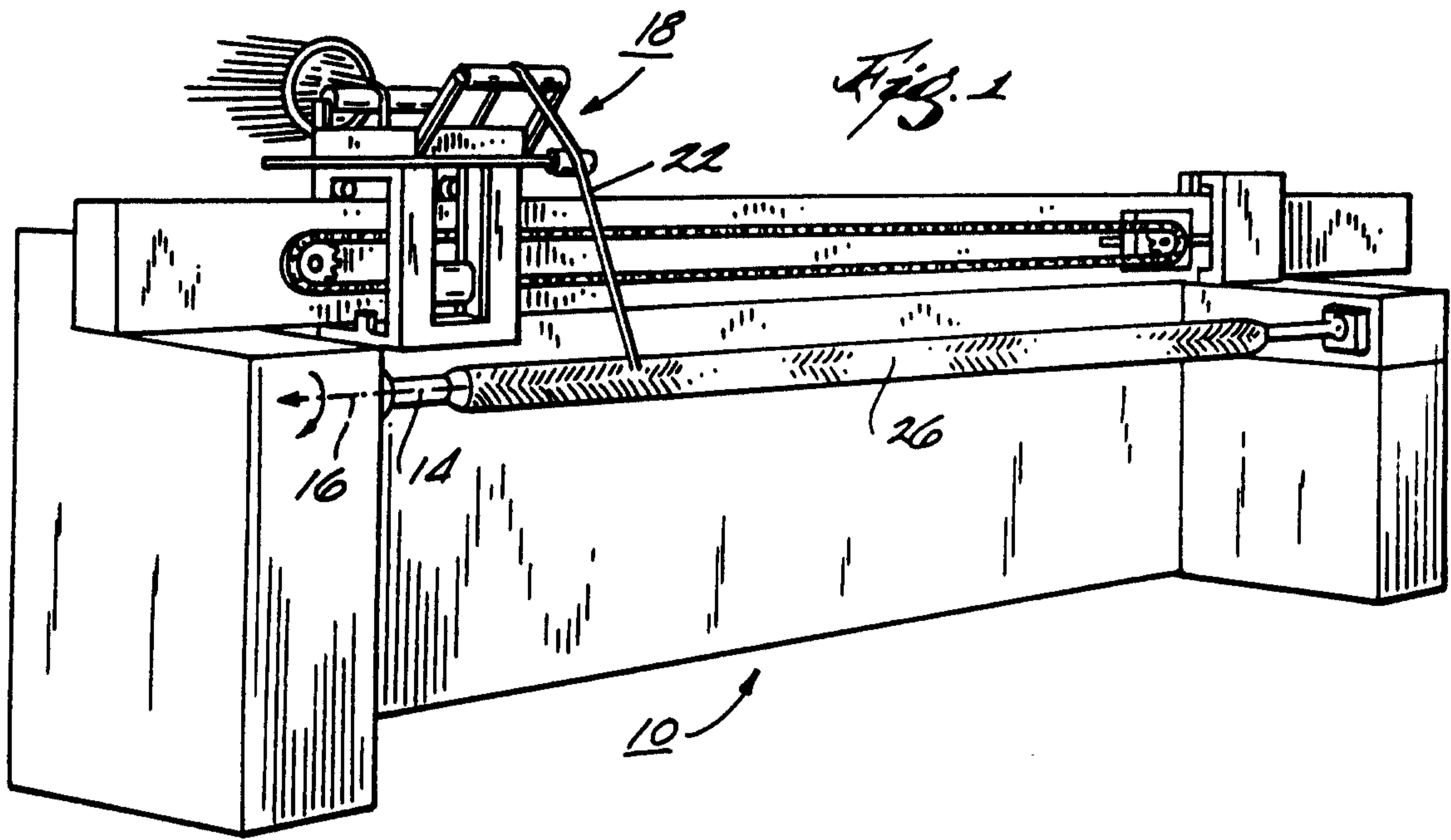
creating openings in said sidewall by varying on a linearly repetitive basis at least one of the strand thickness, the winding angle, and the resin composition, and without removing material from said sidewall after said winding step.

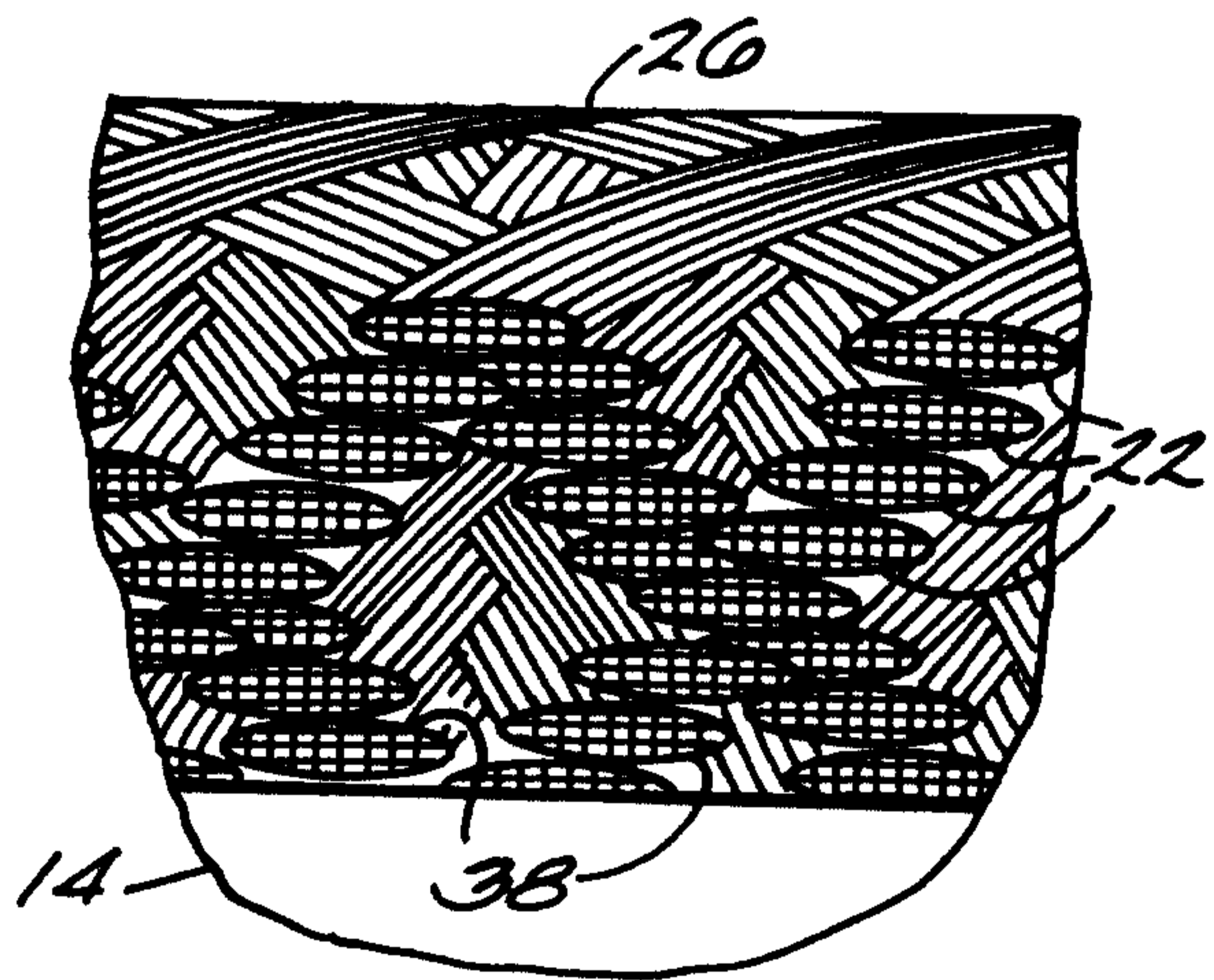
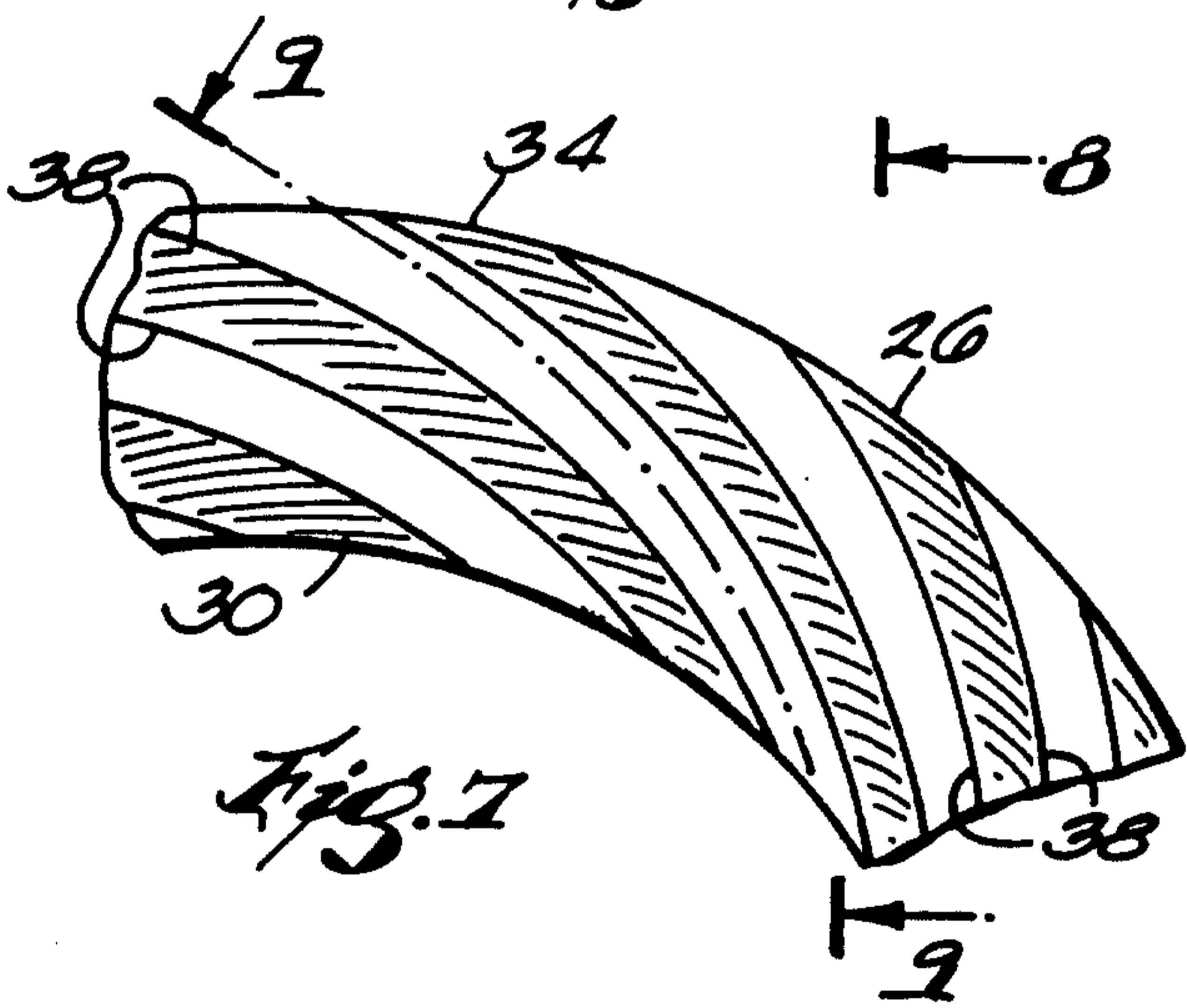
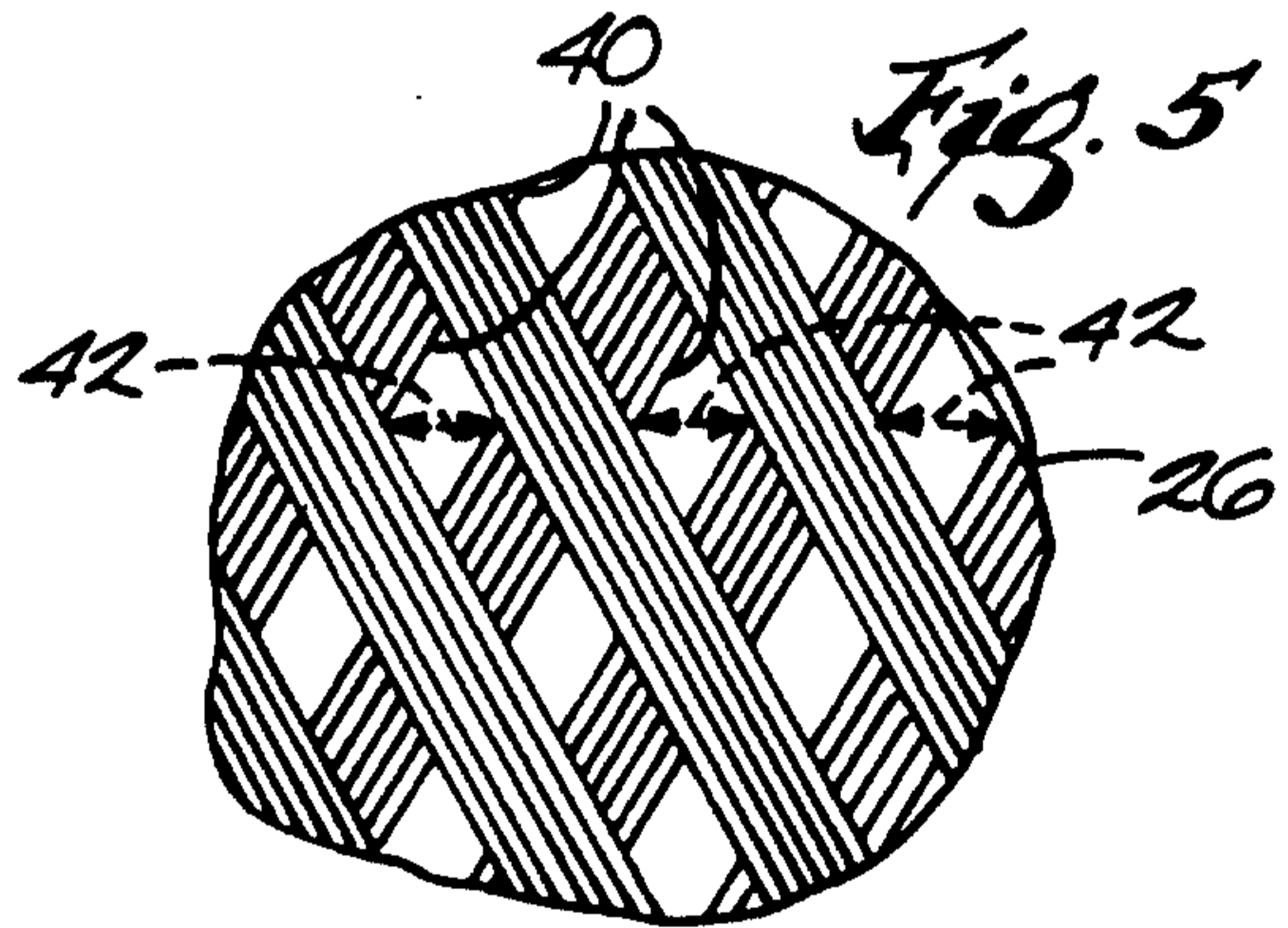
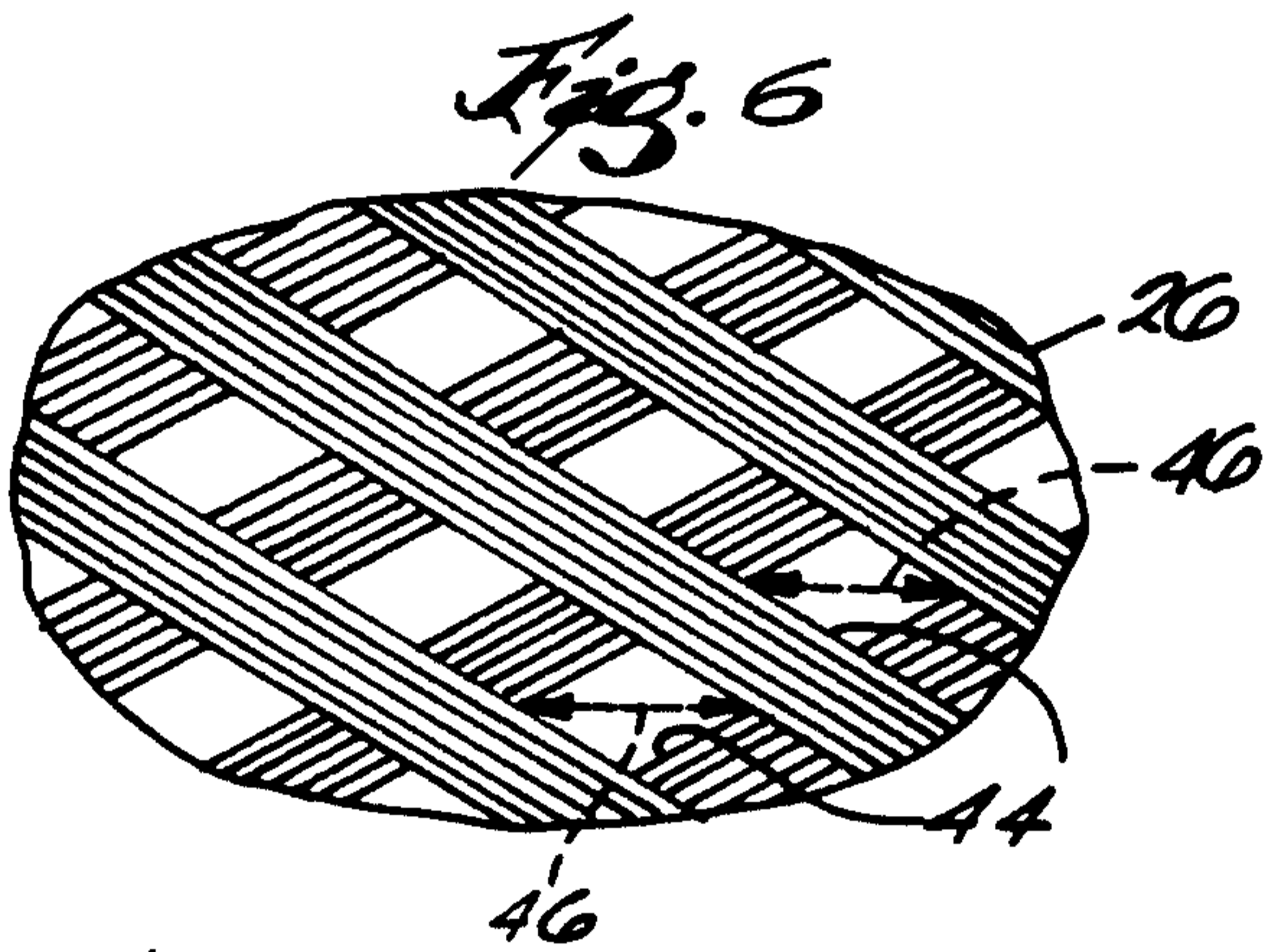
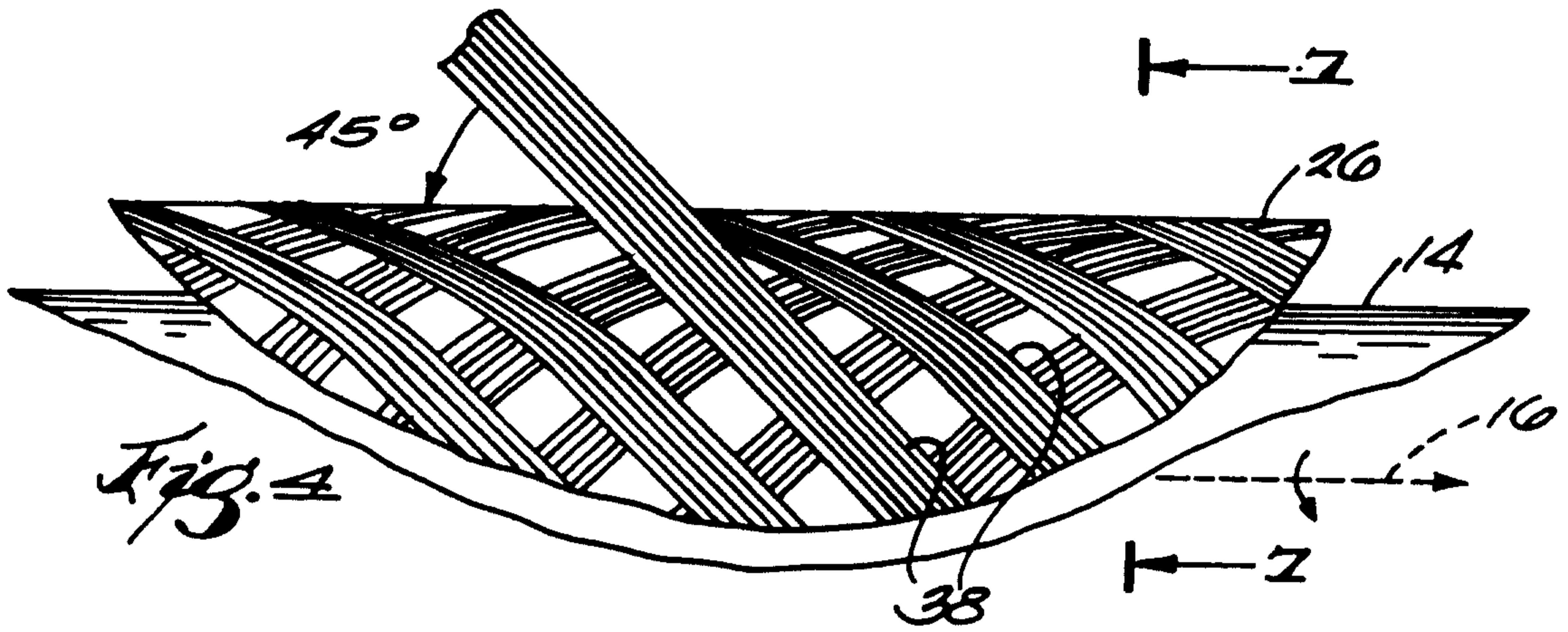
16. A method as set forth in Claim 15 wherein said creating step includes varying all of the strand thickness, the winding angle, and the resin composition.

17. A method as set forth in Claim 15 wherein said creating step includes varying the strand thickness.

18. A method as set forth in Claim 15 wherein said creating step includes varying the winding angle.

19. A method as set forth in Claim 15 wherein said creating step includes varying the resin composition.





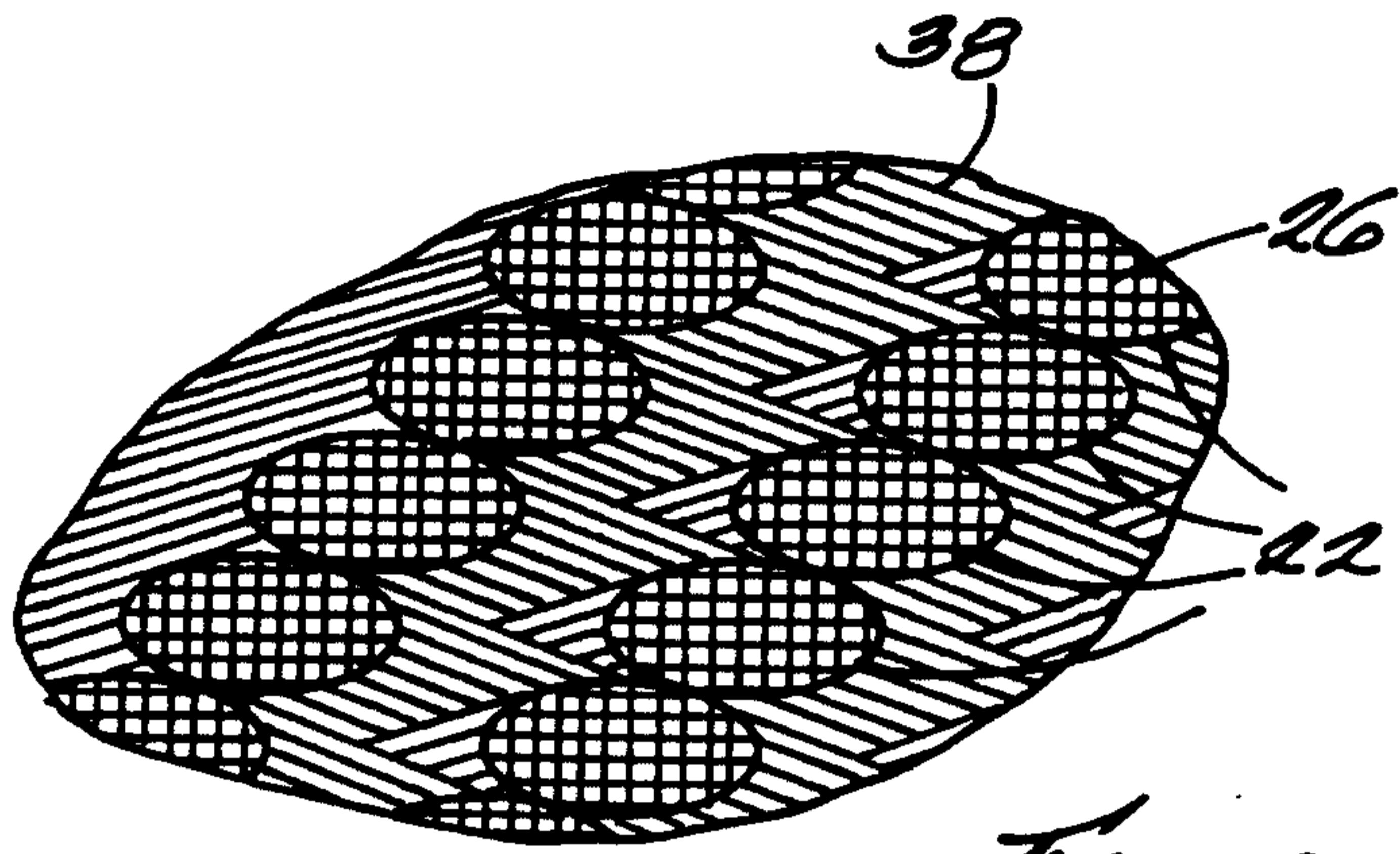


Fig. 9

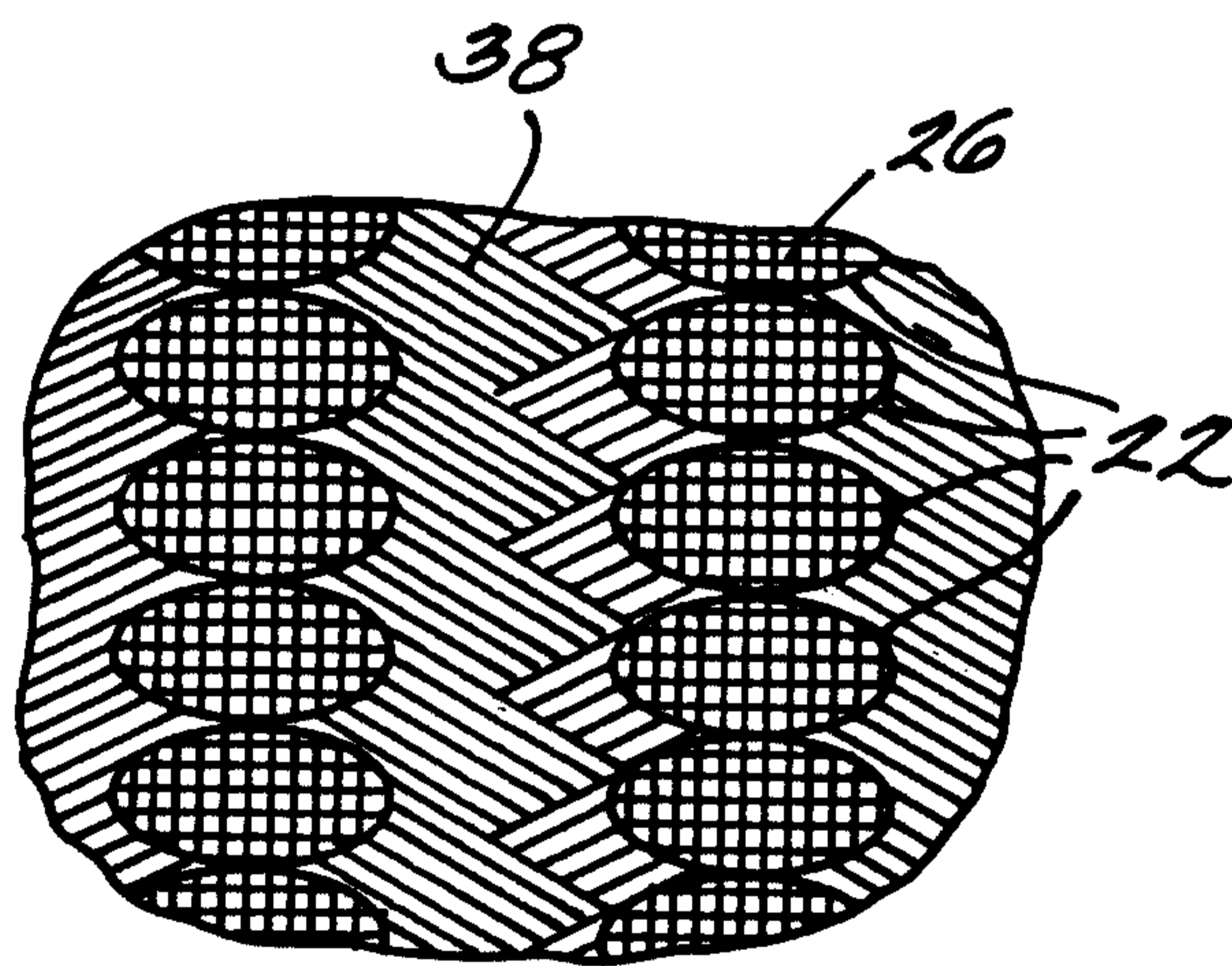


Fig. 10