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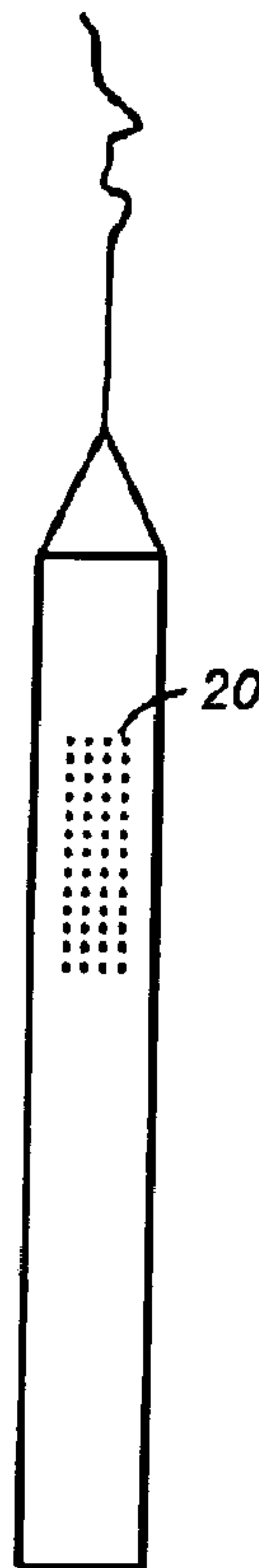
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(54) Titre : FENETRAGE PAR DECOUPAGE AU CHALUMEAU

(54) Title: WINDOW FORMING BY FLAME CUTTING



(57) Abrégé/Abstract:

A tool containing a solid combustible material is used to provide a pipe-cutting flame and to direct a pipe-cutting flame against a casing or tubular. The nozzles can be configured in any desired array and intensity. In the preferred embodiment, a rectangular window is burned away completely if the nozzles are sufficiently intense or the window is formed in segments if other distributions are used. The device can be anchored by a packer or anchor and can be run in the wellbore on tubing, wireline or electric line. The window can be produced in a single trip. The tool can be removed and a kick-off diverter installed adjacent the window for milling the lateral.



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ABSTRACT OF THE INVENTION

A tool containing a solid combustible material is used to provide a pipe-cutting flame and to direct a pipe-cutting flame against a casing or tubular. The nozzles can be configured in any desired array and intensity. In the preferred embodiment, a rectangular window is burned away completely if the nozzles are sufficiently intense or the window is formed in segments if other distributions are used. The device can be anchored by a packer or anchor and can be run in the wellbore on tubing, wireline or electric line. The window can be produced in a single trip. The tool can be removed and a kick-off diverter installed adjacent the window for milling the lateral.

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WINDOW FORMING BY FLAME CUTTING

FIELD OF THE INVENTION

The field of the invention relates to flame-cutting techniques for making windows in casing for drilling laterals in existing wellbores.

5 BACKGROUND OF THE INVENTION

Figure 1a illustrates a traditional method of window forming wherein a starter mill 10 is directed by whipstock 12 into the wall of the casing 14. The typical shape of a window or opening 16 is shown in Figure 1b. The window is narrow when initially cut and proceeds to its maximum width when the mill 10 is approximately in
10 the position shown in Figure 1a as its center is in alignment with the wall of the casing 14. The mill 10 tends to bog down at this point because there is little relative rotation when the center of the mill is in alignment with the wall of the casing 14. As a result, typically mills have been designed to have a build-up of cutting material 18 (shown in Figure 1c) to prevent coring out the starter mill 10 as it bogs down in the position
15 shown in Figure 1a. Eventually, the starter mill 10 continues to cut and the remainder of the window (shown in Figure 1b as the lower half) begins to get progressively narrower until the starter mill 10 exits the window completely.

The traditional technique of using one or more mills, even if done in a one-trip technique involving orientation tools coupled with an anchor or packer, is still fairly
20 time-consuming. Accordingly, one of the objectives of the present invention is to dramatically decrease the time required for formation of the window. Additionally, another objective of the invention is to be able to cut any desired window shape in a minimum amount of time, with the result that minimum debris or residue is left after employing the technique. Another objective is to eliminate the typical window profile
25 illustrated in Figure 1b so that shorter kickoff diverters can be used when drilling the lateral through the window that is produced.

In the past, casing to be cut in two in a wellbore has been cut using techniques involving ignited combustible materials which are directed to a radial nozzle or
nozzles to cut cleanly through the casing or tubular. These types of devices using a
30 cutting flame radially to cut through a pipe are illustrated in U.S. Patent Nos.

4,598,769 and 5,435,394. These devices are limited-purpose tools for cutting radially through a casing.

Explosive techniques for making a window in casing, using a shaped charge attached to a starter mill which is, in turn, attached to a whipstock, is illustrated in
5 U.S. Patent No. 5,636,692.

Another objective of the present invention is to use flame-cutting techniques to produce a window of desired shape rapidly to facilitate further downhole operations.

These aspects of the method will be more readily understood by those skilled in the art from a review of the details of the preferred embodiment described below.

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SUMMARY OF THE INVENTION

A tool containing a solid combustible material is used to provide a pipe-cutting flame and to direct a pipe-cutting flame against a casing or tubular. The nozzles can be configured in any desired array and intensity. In the preferred
15 embodiment, a rectangular window is burned away completely if the nozzles are sufficiently intense or the window is formed in segments if other distributions are used. The device can be anchored by a packer or anchor and can be run in the wellbore on tubing, wireline or electric line. The window can be produced in a single trip. The tool can be removed and a kick-off diverter installed adjacent the window
20 for milling the lateral.

Accordingly, in one aspect of the present invention there is provided a method of forming a lateral from a wellbore comprising:

providing a self-contained body having:

an array of nozzles arranged to define a generally elongate shape; and

5 a combustible material;

positioning the body in a tubular of the wellbore;

igniting the combustible material and allowing products of the combustion to flow through the nozzles to form a generally elongate window in the tubular, the shape of the window substantially corresponding to the shape defined by the array of

10 nozzles;

diverting a tool through the window; and

forming the lateral with the tool to extend through the window.

According to another aspect of the present invention there is provided a method for providing an access through a wall of a wellbore tubular, comprising:

15 providing a body having an array of nozzles and a combustible material

contained within the body, wherein the nozzles are arranged in close quarters so as not to leave tubular debris in the wellbore adjacent the nozzles;

positioning the body in the wellbore tubular;

igniting the combustible material and allowing products of the combustion to

20 flow through the array of nozzles thereby forming the access; and

locating a diverter member proximate the previously-formed access for diverting a tool through the access.

According to yet another aspect of the present invention there is provided a method for forming a lateral wellbore through a wall of a wellbore tubular, comprising:

- 5 providing a body having an array of nozzles and a combustible material contained within the body;
- arranging the nozzles to define a substantially rectangular shaped window;
- positioning the body in the wellbore tubular;
- igniting the combustible material and allowing products of the combustion to flow through the array of nozzles thereby forming a window;
- 10 locating a diverter member proximate the window after the window is formed;
- and
- forming a lateral wellbore through the previously-formed window.

According to still yet another aspect of the present invention there is provided a method for forming a lateral wellbore through a wall of a wellbore tubular, comprising the steps of:

- 15 providing a body having an array of nozzles and a combustible material contained within the body, wherein the nozzles are arranged to dispense products of combustion in a predetermined pattern;
- positioning the body in the wellbore tubular;
- 20 igniting the combustible material and dispensing the products of combustion through the nozzles thereby forming an opening through a wall in the wellbore tubular;
- diverting a tool through the formed opening; and
- forming the lateral wellbore with the tool.

4a

BRIEF DESCRIPTION OF THE DRAWINGS

Embodiments of the present invention will now be described more fully with reference to the accompanying drawings in which:

Figure 1a is a sectional elevational view of the prior art technique for milling a
5 window using a starter mill and a whipstock.

Figure 1b is the resulting window made by using the technique shown in Figure 1a.

Figure 1c is the view of a typical starter mill used for making windows in the prior art.

10 Figure 2 illustrates a radial flame cut produced by a prior art pipe-cutting apparatus illustrated in U.S. Patent No. 4,598,769.

Figure 3 illustrates the flame jet distribution in a rectangular high-intensity pattern for burning a complete window in a casing or tubular.

Figure 4 shows an alternative to Figure 3 where a rectangular window is
15 burned at its periphery, leaving a single residual piece to come out of the casing wall.

Figure 5 is an alternative to Figure 4, indicating two pieces falling from the casing or tubular when making a rectangular window.

Figure 6 is an alternative to Figure 5, making an overall rectangular window by burning away smaller rectangularly shaped pieces.

20 Figure 7 is an alternative to Figure 6, illustrating the technique for making a rectangular window, leaving triangular and diamond-shaped pieces.

Figure 8 illustrates the tool in casing having a rectangular pattern with an intensity sufficient to burn away a rectangular opening in the casing.

Figure 9 is the tool of Figure 8 shown as fired.

25 Figure 10 shows the window made from firing as reflected in Figure 9. Figure 11 illustrates the use of an anchor or packer or bridge plug for support of the tool in the run-in position.

Figure 12 shows the fully supported position for the tool prior to firing.

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Figure 13 shows the formation of a rectangular window and the subsequent removal of the tool, exposing an anchor for a kick-off diverter.

Figure 14 shows the installation of the kick-off diverter and the drillstring for drilling the lateral through the window.

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DETAILED DESCRIPTION OF THE PREFERRED EMBODIMENT

The method of the present invention is illustrated in the attached figures. The flame-cutting apparatus, first described in U.S. Patent No. 4,598,769, is reconfigured to have a plurality of nozzles arranged in a variety of patterns. Figure 3 illustrates a
10 generally rectangular orientation of nozzles 20, placed in very close quarters so that when actuated, as shown in Figure 9, a rectangular opening 22, shown in Figure 10, can be produced without any casing segments falling into the wellbore. In essence, the intense heat delivered by the nozzles 20 in a closely confined array, such as shown in Figure 3, essentially at 6000°F or higher, results in the formation of the window 22
15 without any significant debris in the wellbore.

Referring to Figure 4, a rectangular window is formed by cutting the periphery of the window, leaving a piece of the casing 24 as debris in the wellbore. Figure 5 is similar to Figure 4 except that an additional longitudinal row 26 has been added so that the debris comprises of two pies 28 and 30. Figures 6 and 7 illustrate alternative
20 nozzle patterns which result, respectively, in a series of rectangular pieces of debris 32 when making a rectangular window, or, as shown in Figure 7, a combination of triangular and parallelogram shapes 34 and 36, respectively.

Figure 8 illustrates schematically running the tool T into the casing 38. The support 40 is shown schematically and can be an electric line, wireline, or coiled
25 tubing, and can also include known orientation equipment to properly position the tool T before it is fired. Figure 9 illustrates the tool with a layout of nozzles 20 akin to that shown in Figure 3 being fired, while Figure 10 illustrates the window 22 after the tool has been removed.

Figure 11 is a more detailed view of the method of the present invention.
30 Here, a packer or bridge plug 42 supports an anchor 44, which eventually accepts a short diverter 46 as shown in Figure 14. The packer or bridge plug 42 has slips 48

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which are retracted in Figure 11 and set in Figure 12. The orientation is determined prior to setting the slips 48, using a known measurement-while-drilling (MWD) tool, which is part of the assembly of support 40. Thereafter, as shown in Figure 13, the tool T is fired to make the window 22 and is subsequently released from the anchor
5 44. The diverter 46 is configured so that when it is secured to the anchor 44, it points into window 22. In using the method of the present invention, the shape of the window can be more certainly relied upon as being rectangular, as opposed to techniques in the prior art which resulted in a more elliptical shape, as shown in Figure 1b. Thus, the diverter 46 can be of fairly short length. Another advantage is
10 that with the window 22 being produced essentially rectangular, the mill 50 does not bog down when it is about half-way through the window, as in the prior art illustrated in Figure 1a. The reason for this is that there is no longer any metal to mill through at a time when there is little relative rotation between the bit 50 and the casing 38.

Since the opening 22 is reliably rectangular, the placement of the diverter 46 is
15 not as critical as in the prior art, where the shape of the window was more elliptical, as shown in Figure 1b. With the window 16 having the shape shown in Figure 1b, it was more important to position the diverter to get the bit kicked off toward the widest spot in the window. With a reliably made rectangular opening, vertical placement of the diverter 46 is not critical.

20 The foregoing disclosure and description of the invention are illustrative and explanatory thereof, and various changes in the size, shape and materials, as well as in the details of the illustrated construction, may be made without departing from the spirit of the invention.

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What is claimed is:

1. A method of forming a lateral from a wellbore comprising:
providing a self-contained body having:
5 an array of nozzles arranged to define a generally elongate shape; and
a combustible material;
positioning the body in a tubular of the wellbore;
igniting the combustible material and allowing products of the combustion to
flow through the nozzles to form a generally elongate window in the tubular, the
10 shape of the window substantially corresponding to the shape defined by the array of
nozzles;
diverting a tool through the window; and
forming the lateral with the tool to extend through the window.
- 15 2. The method of claim 1, wherein the nozzles are arranged in close quarters so
as not to leave tubular debris in the wellbore.
3. The method of claim 1 or 2, wherein at least one row of the nozzles is
provided that spans the periphery between opposed portions.
- 20 4. The method of claim 1, 2 or 3, wherein the window to be formed in the
wellbore tubular is generally rectangularly shaped.
5. The method of any one of claims 1 to 4, wherein the window is formed in a
single trip.
- 25 6. The method of any one of claims 1 to 5, wherein the body is run into the
wellbore tubular on one of an electric line, a wireline and a coiled tubing.
7. The method of any one of claims 1 to 6, wherein a support and an orientation

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device for the nozzles are run in with the body.

8. The method of any one of claims 1 to 7, wherein a diverter is located in the vicinity of the window for diverting the tool through the window.

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9. The method of claim 8, wherein the diverter is located after the window has been formed.

10. The method of any one of claims 1 to 9, wherein the combustible material
10 comprises a solid combustible material.

11. A method for providing an access through a wall of a wellbore tubular, comprising:

providing a body having an array of nozzles and a combustible material
15 contained within the body, wherein the nozzles are arranged in close quarters so as not to leave tubular debris in the wellbore adjacent the nozzles;

positioning the body in the wellbore tubular; igniting the combustible material and allowing products of the combustion to flow through the array of nozzles thereby forming the access; and

20 locating a diverter member proximate the previously-formed access for diverting a tool through the access.

12. The method of claim 11, wherein the access comprises a generally rectangularly shaped window in the tubular.

25

13. The method of claim 12, further comprising running said body into the wellbore tubular on a tool selected from the group consisting of electric line, wireline, and coiled tubing.

30 14. The method of any one of claims 11 to 13, further comprising forming said window in a single trip.

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15. The method of claim 14, further comprising running in a support and an orientation device for said nozzles with said body.
- 5 16. A method for forming a lateral wellbore through a wall of a wellbore tubular, comprising:
- providing a body having an array of nozzles and a combustible material contained within the body;
- arranging the nozzles to define a substantially rectangular shaped window;
- 10 positioning the body in the wellbore tubular;
- igniting the combustible material and allowing products of the combustion to flow through the array of nozzles thereby forming a window;
- locating a diverter member proximate the window after the window is formed; and
- 15 forming the lateral wellbore through the previously-formed window.
17. The method of claim 16, further comprising running said body into the wellbore tubular on a tool selected from the group consisting of electric line, wireline, and coiled tubing.
- 20 18. The method of claim 16 or 17, further comprising forming said window in a single trip.
19. The method of claim 18, further comprising running in a support and an orientation device for said nozzles with said body.
- 25 20. A method for forming a lateral wellbore through a wall of a wellbore tubular, comprising the steps of:
- providing a body having an array of nozzles and a combustible material
- 30 contained within the body, wherein the nozzles are arranged to dispense products of combustion in a predetermined pattern;

- 10 -

positioning the body in the wellbore tubular;
igniting the combustible material and dispensing the products of combustion
through the nozzles thereby forming an opening through a wall in the wellbore
tubular;

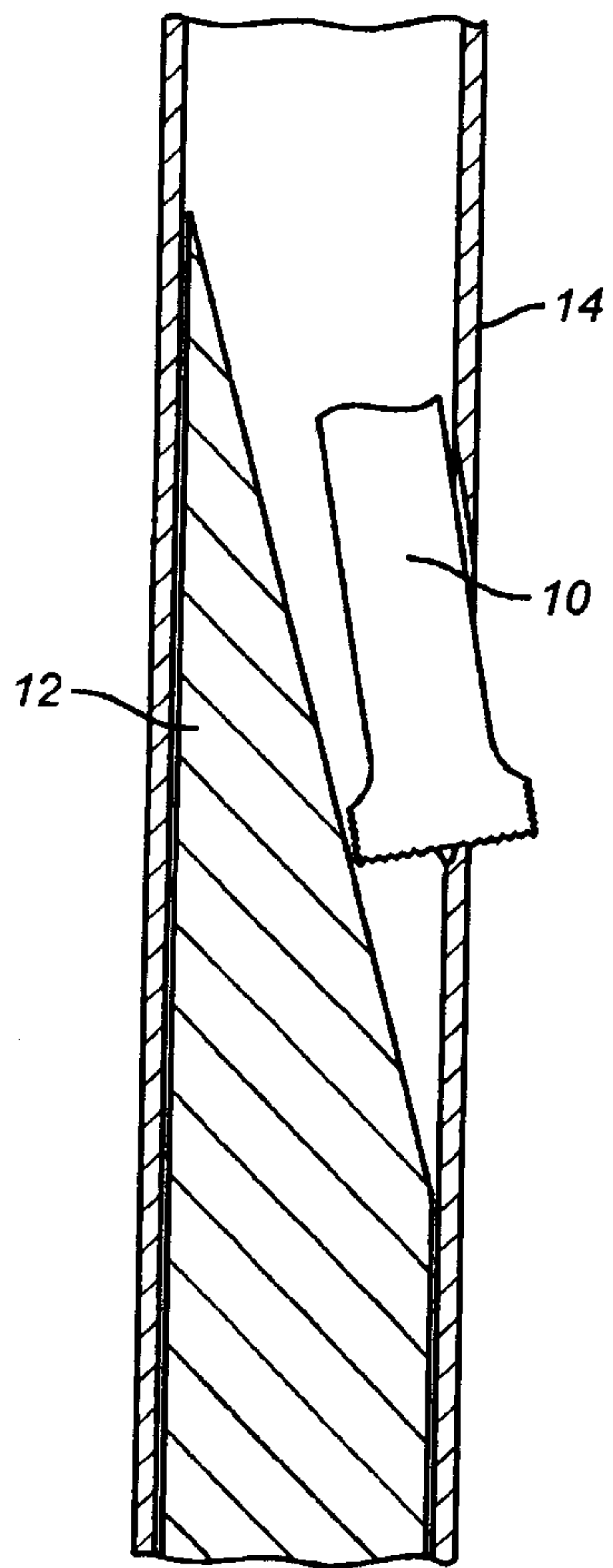
5 diverting a tool through the formed opening; and
 forming the lateral wellbore with the tool.

21. The method of claim 20, further comprising the step of:
 locating a diverter adjacent the opening.

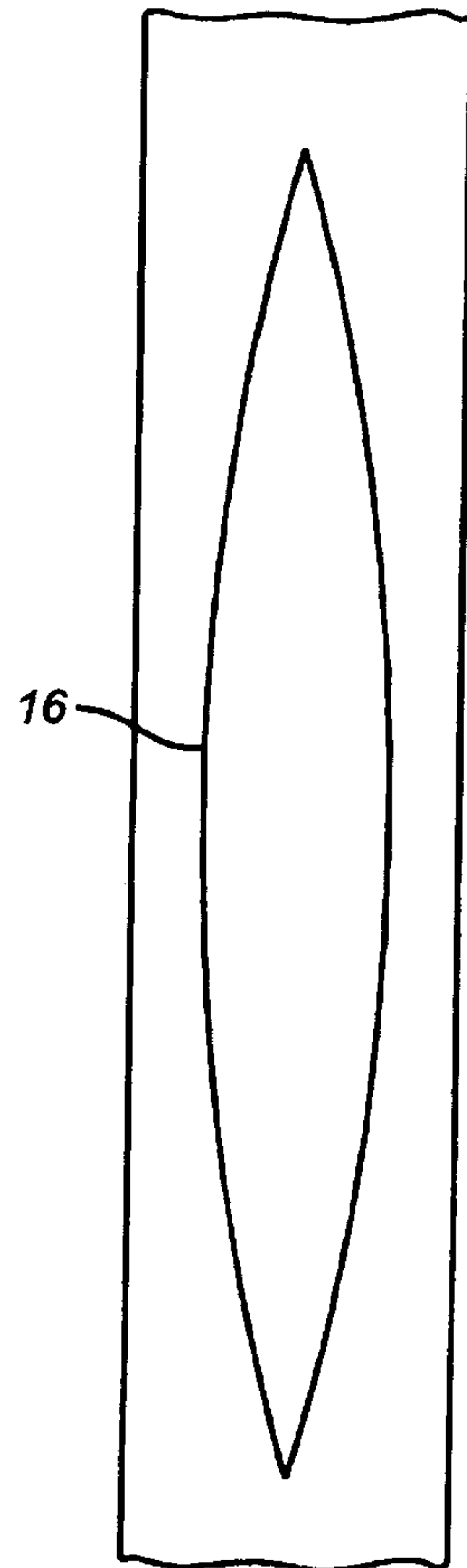
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22. The method of claim 20 or 21, wherein the opening is substantially
rectangular.

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(PRIOR ART)
FIG. 1a



(PRIOR ART)
FIG. 1b

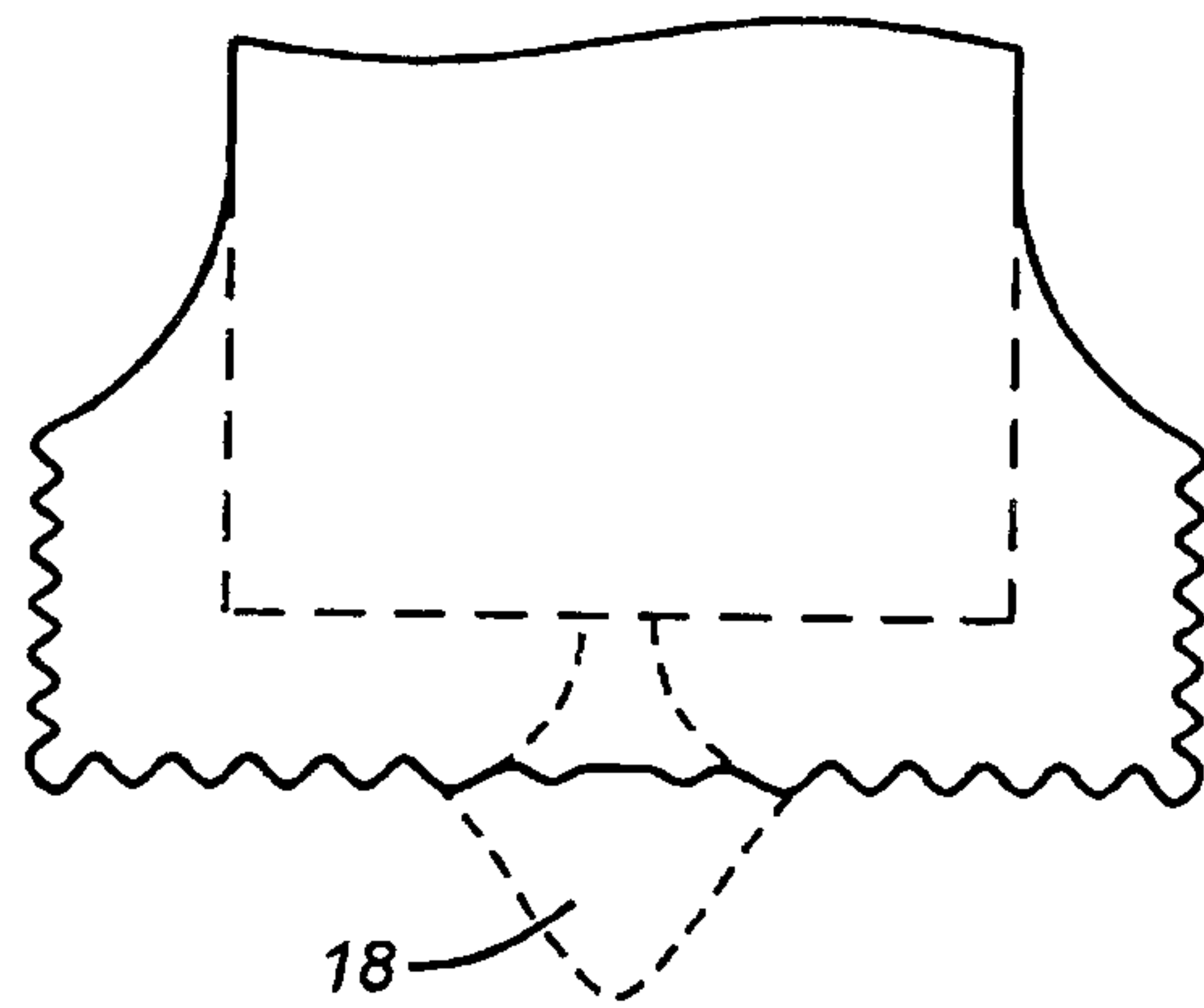
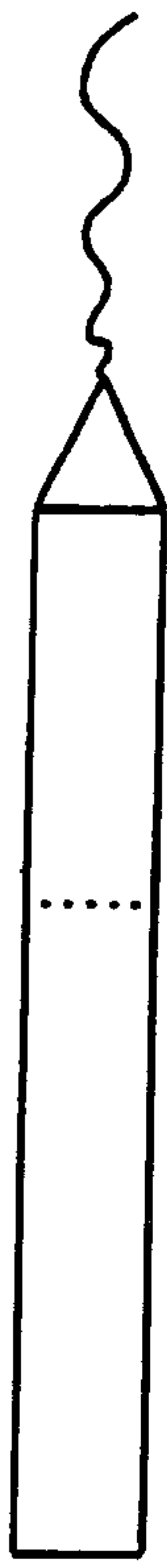
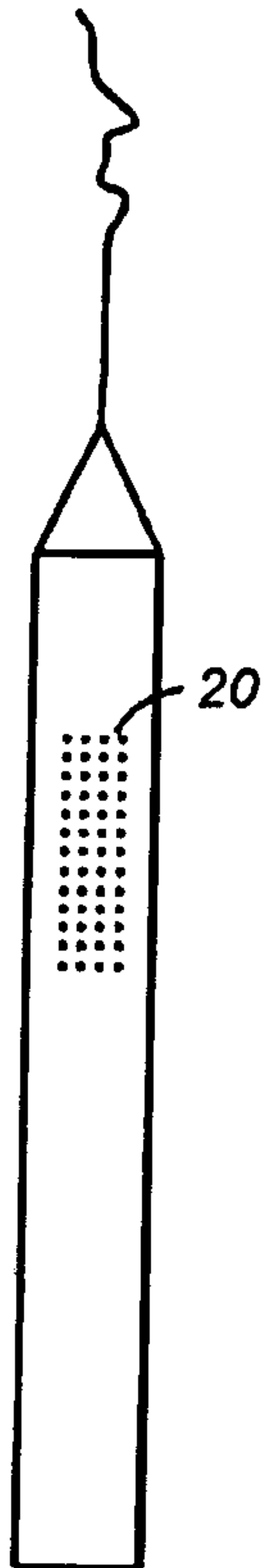
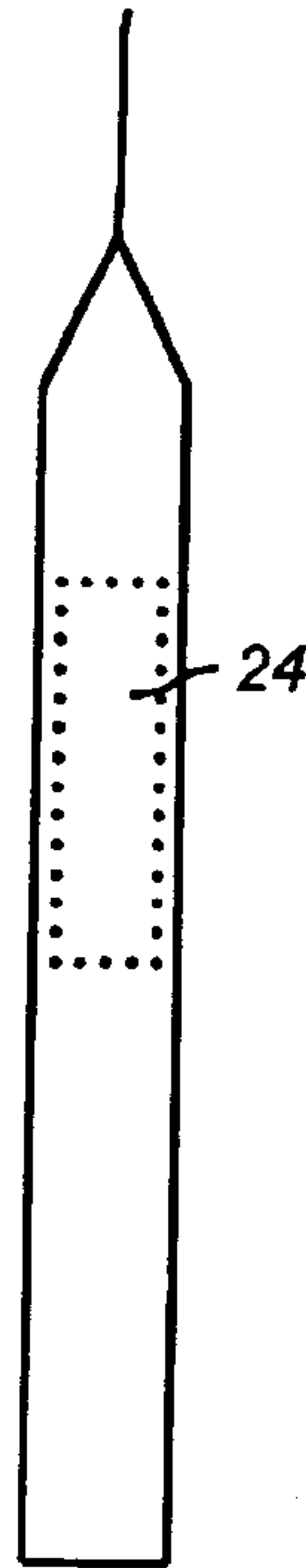
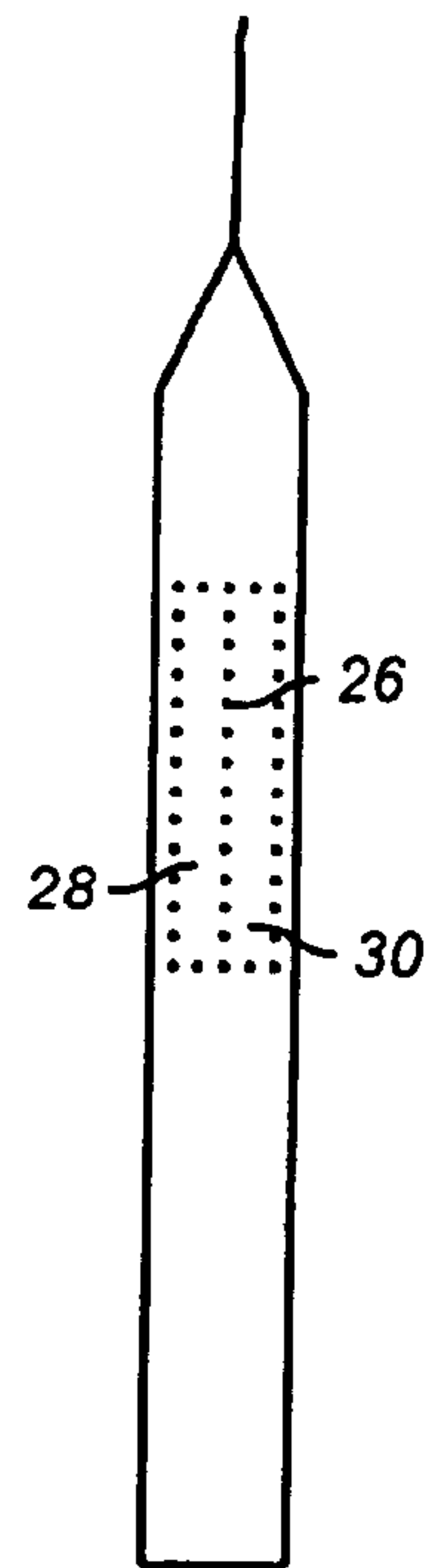
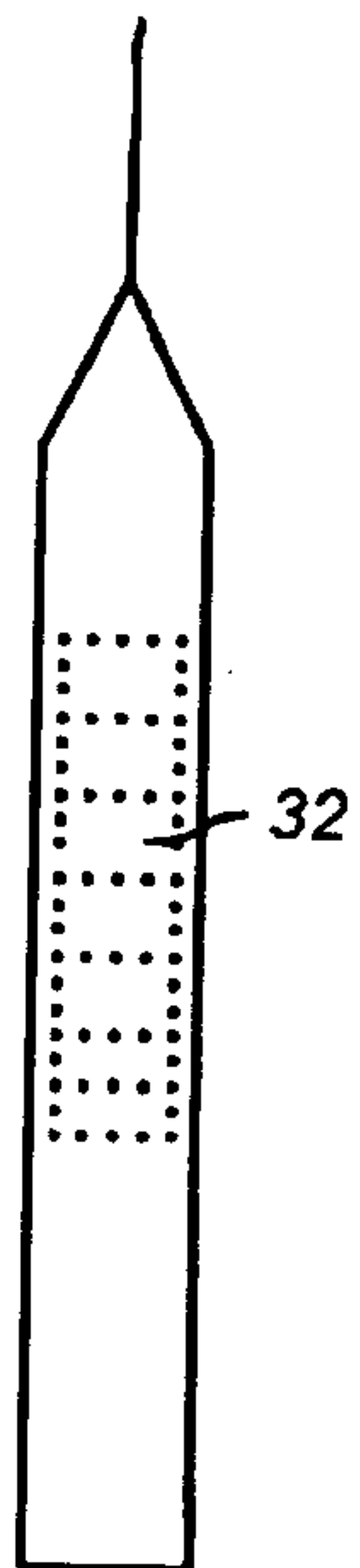
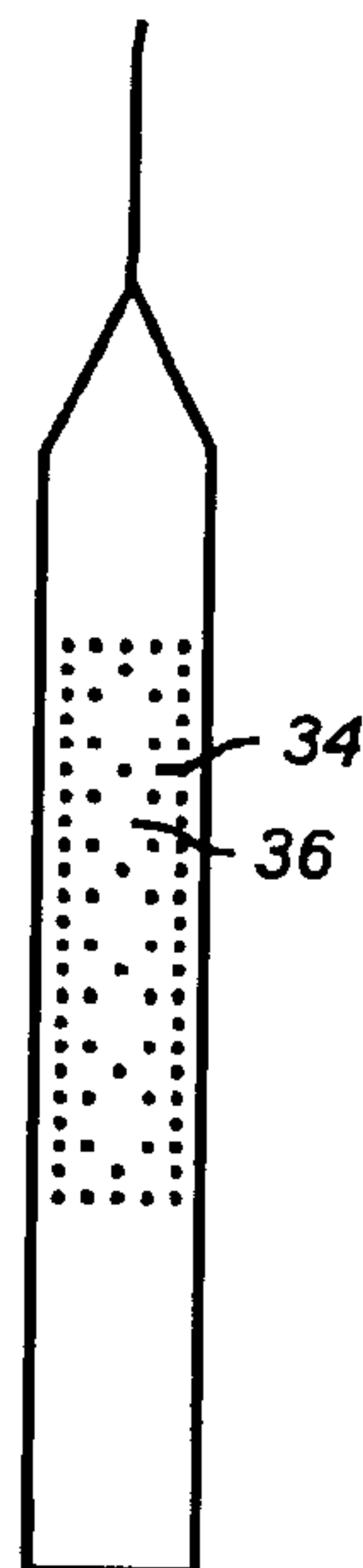


FIG. 1c

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*(PRIOR ART)***FIG. 2****FIG. 3****FIG. 4****FIG. 5****FIG. 6****FIG. 7**

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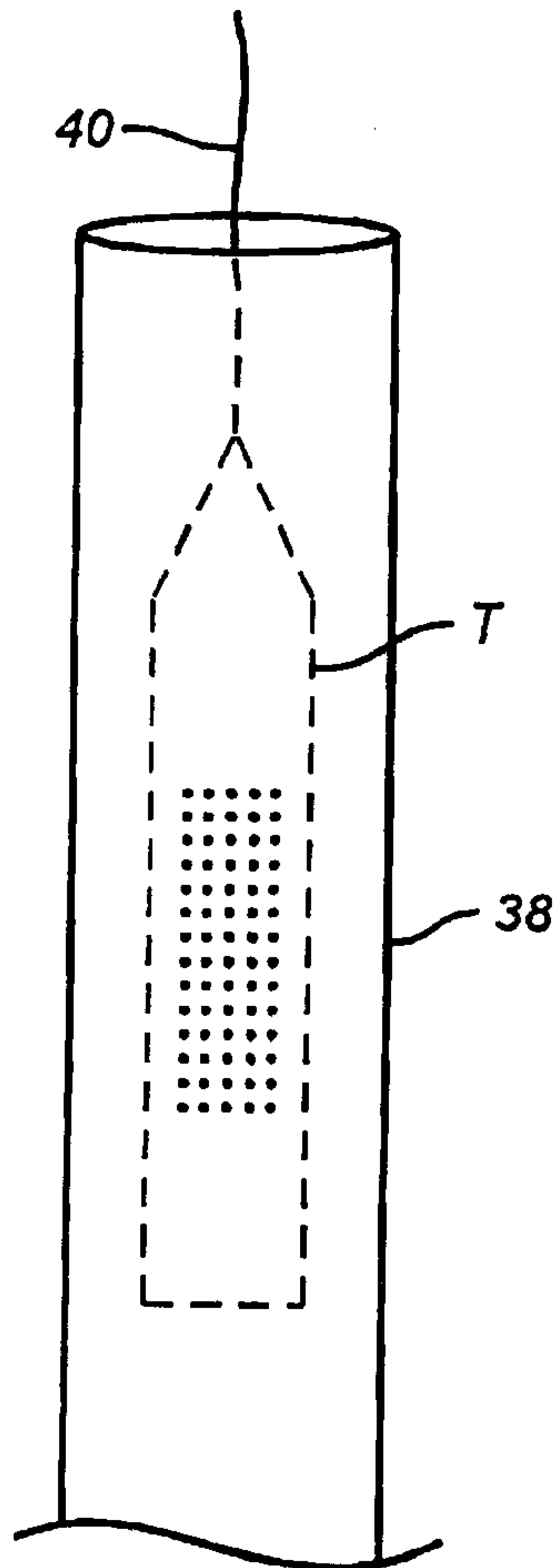


FIG. 8

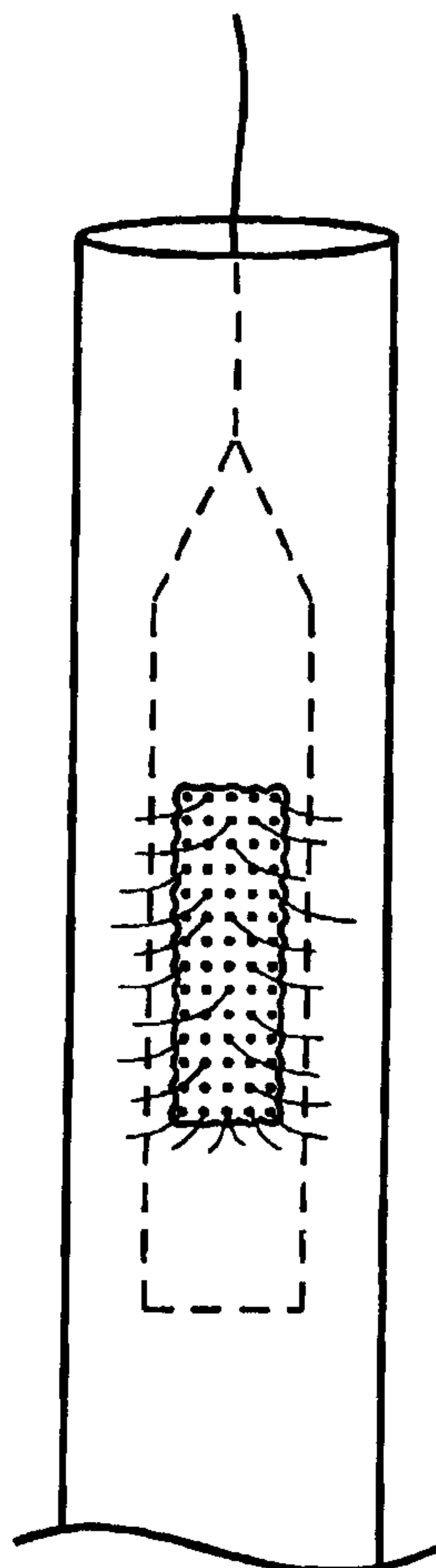


FIG. 9

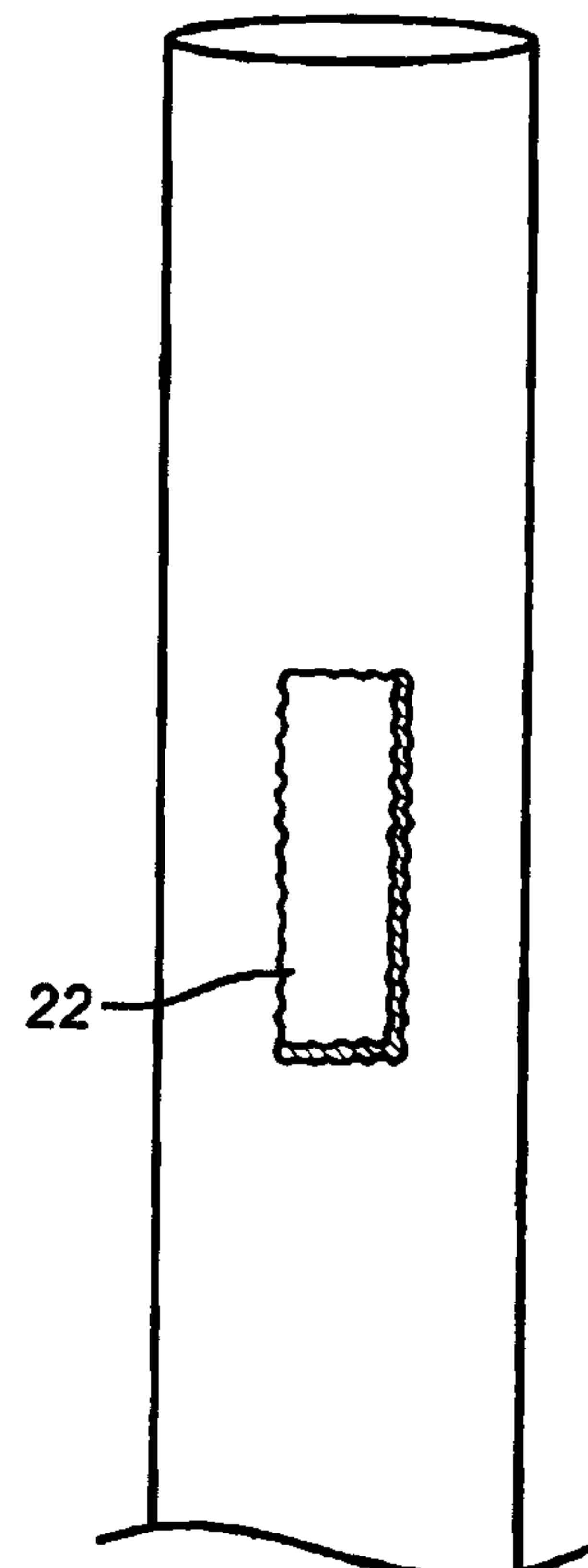
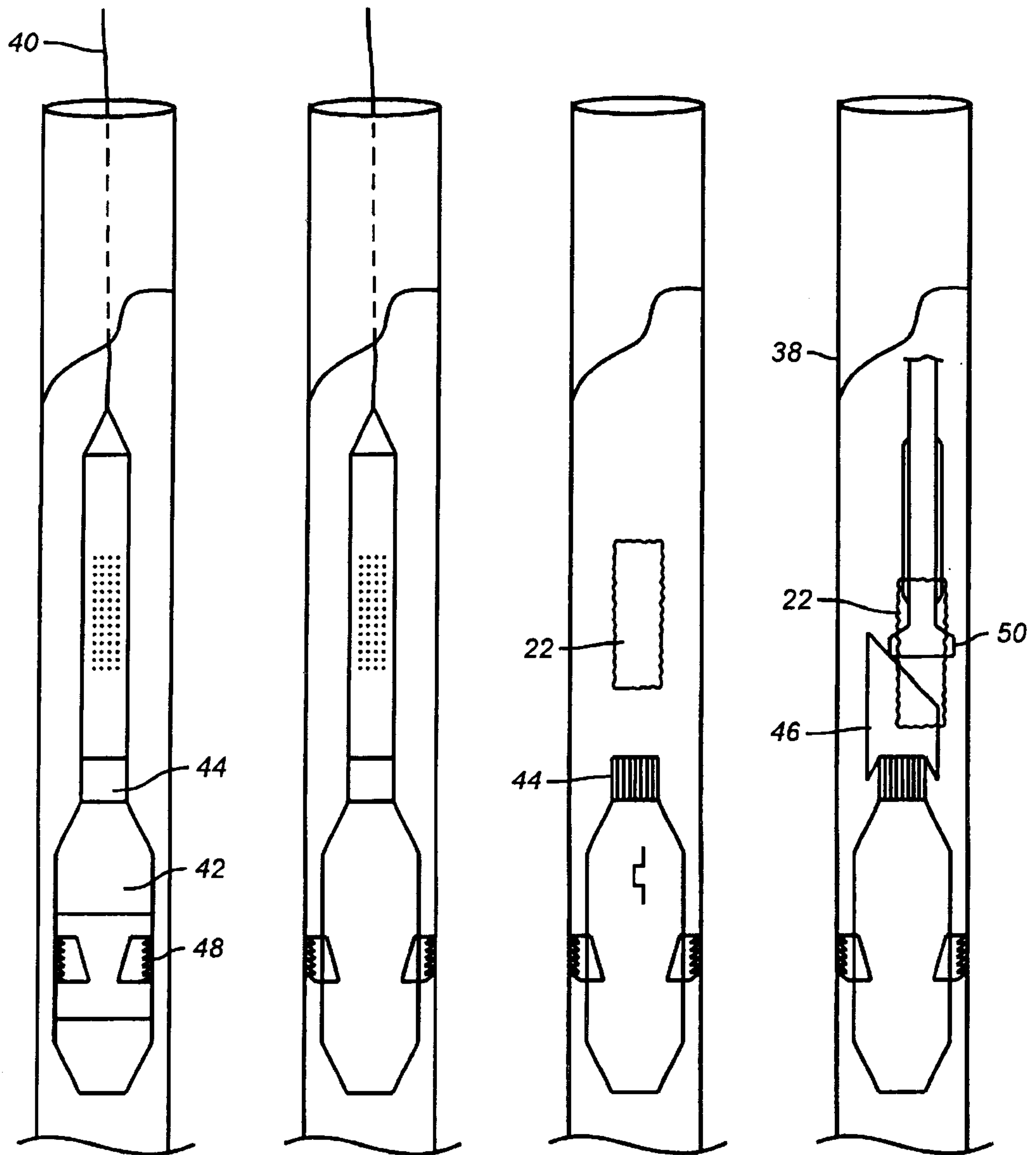


FIG. 10

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**FIG. 11****FIG. 12****FIG. 13****FIG. 14**

