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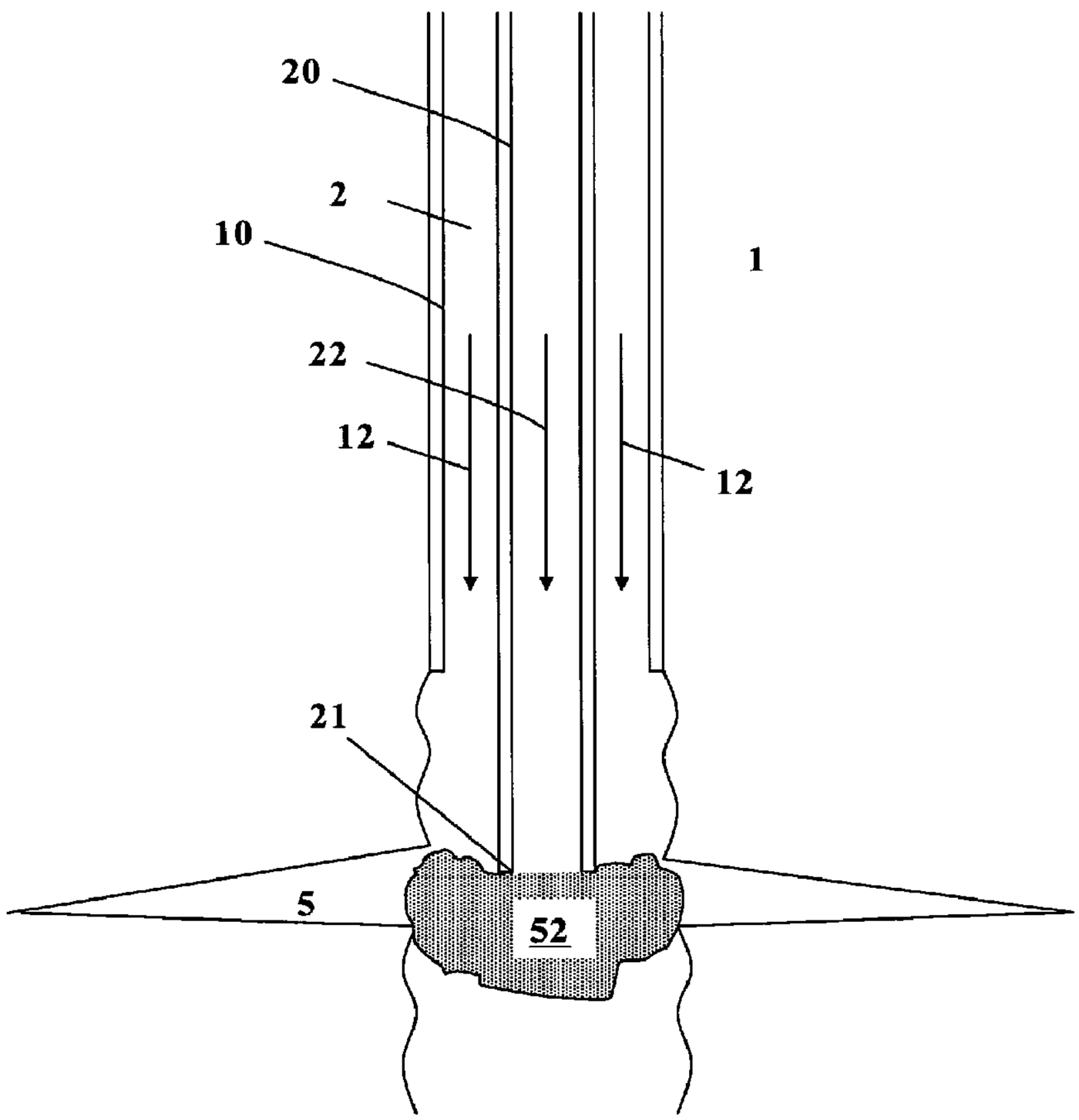
(54) Titre : PROCEDE POUR RESOUDRE LA PERTE DE CIRCULATION
(54) Title: METHOD TO CURE LOST CIRCULATION



(57) Abrégé/Abstract:
The invention provides a method to cure lost circulation in a zone (5) of a wellbore (1), comprising the steps of: placing a first pipe (10) in the wellbore; placing a second pipe (20) inside said first pipe and creating an annular (2); wherein said first pipe and said

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(57) Abrégé(suite)/Abstract(continued):
second pipe are arranged such that the end of the second pipe (21) is located in the vicinity of the zone (5); pumping a first material (12) via the annular of the first pipe; pumping a second material (22) via the second pipe, wherein said first material and said second material create a solid foam (52) when in contact; and creating said solid foam in the vicinity of the zone such that the lost circulation be cured.

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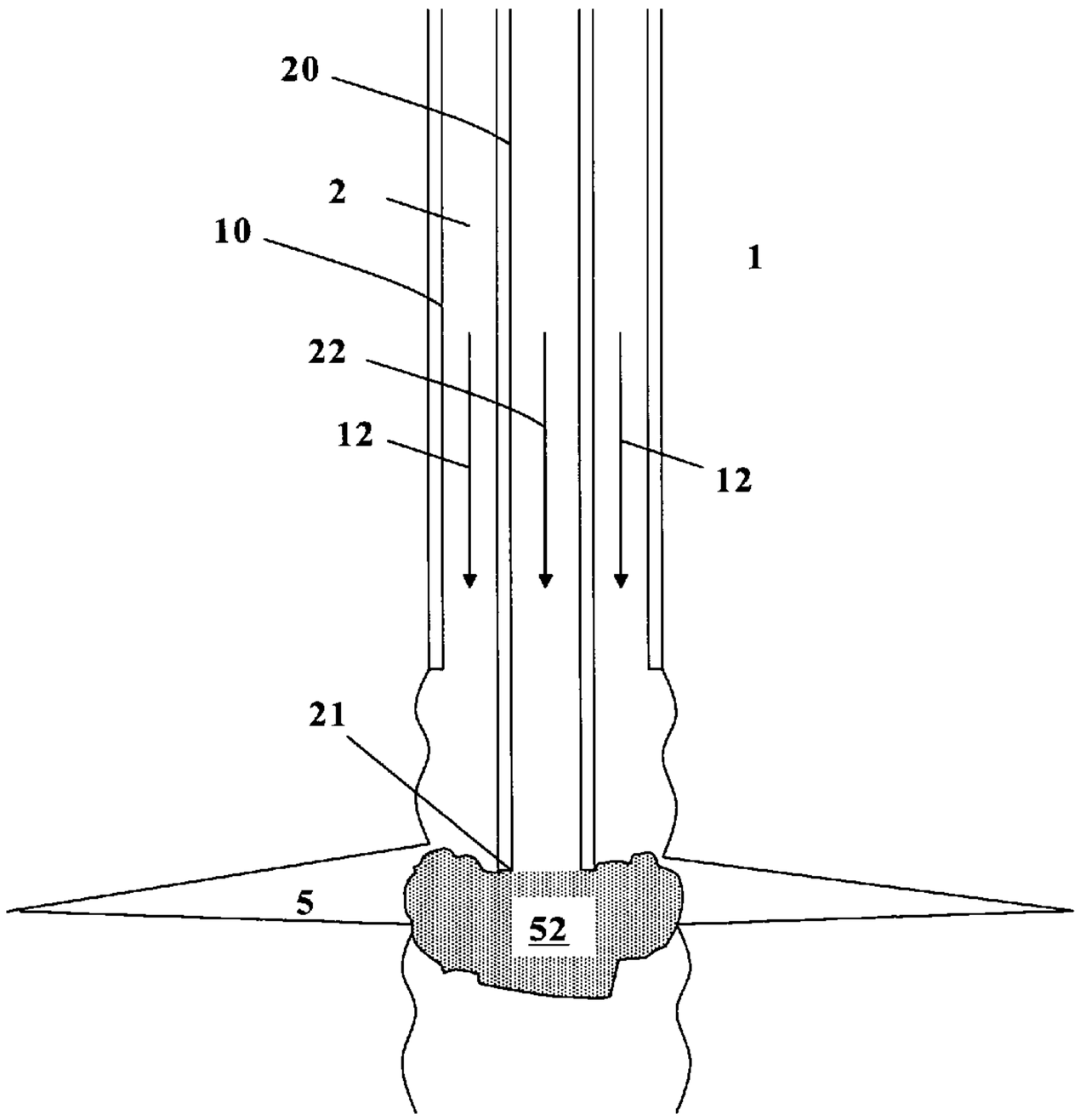
(54) Title: METHOD TO CURE LOST CIRCULATION



(57) Abstract: The invention provides a method to cure lost circulation in a zone (5) of a wellbore (1), comprising the steps of: placing a first pipe (10) in the wellbore; placing a second pipe (20) inside said first pipe and creating an annular (2); wherein said first pipe and said second pipe are arranged such that the end of the second pipe (21) is located in the vicinity of the zone (5); pumping a first material (12) via the annular of the first pipe; pumping a second material (22) via the second pipe, wherein said first material and said second material create a solid foam (52) when in contact; and creating said solid foam in the vicinity of the zone such that the lost circulation be cured.

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Method to cure lost circulation.

Field of the invention

[0001] The present invention broadly relates to well cementing. More particularly the invention relates to a method to cure lost circulation occurring when drilling wells from a subterranean reservoir, such as for instance an oil and gas reservoir or a water reservoir.

Description of the Prior Art

[0002] The cementing of casings in boreholes for stabilization and zonal isolation is well known, especially in the field of well construction in the oil and gas industry. Such operations are performed at various stages while the well is being drilled. In a casing operation, the drill string used to drill the borehole is withdrawn and a tubular casing run into the borehole such that a space is left between the outer surface of the casing and the wall of the borehole (an annulus). Cement slurry is then pumped down the inside of the casing such that it exits the casing at the bottom and flow back towards the surface in the annulus. When the cement sets, the casing is fixed in the borehole and the various layers through which the borehole passes are supported and isolated by the cement and casing. Drilling is then resumed, but at a smaller diameter than previously because of the presence of the casing.

[0003] Setting casing can be useful to support a weak formation or to seal off zones of high or low pressure to prevent uncontrolled influx of fluids or damage to the formation due to the use of dense drilling fluids to balance high formation pressures. During drilling, lost circulation can occur when drilling fluids or cement slurries are lost into highly permeable zones, cavernous formations or natural/induced fractures during drilling or cementing operations. Lost circulations are an expensive and time-consuming problem and therefore it is necessary to cure rapidly and successfully lost circulation. Prior art's methods are known to cure lost circulation. The current method proposes an

alternative solution that can create quickly a foam to avoid lost circulation in the welllbore.

Summary of the invention

[0004] The invention proposed here discusses the methodology of dual injection in various ways with a potential of reducing or eliminating issues related with conventional dual injection technique. One of the methods in the present invention suggests improved downhole mixing of the chemicals to produce polyurethane foam with a variable density to cure lost circulation. The invention also provides a primary base for secondary treatment in the lost circulation zone. The polymer foam will expand downhole covering larger area of the lost circulation zone. The proposed invention not only suggests an enhanced downhole mixing of the chemicals, but also incorporation of the swellable materials and fibers that can improve the physical properties of a loss circulation material. The polymer foam itself can be good enough to cure the losses, but it also creates a base for the second treatment e.g. denser polymer foam, loss circulation pills, or cement plug etc

[0005] According to one aspect of the invention, the invention provides a method to cure lost circulation in a zone of a wellbore, comprising the steps of: (1) placing a first pipe in the wellbore; (2) placing a second pipe inside said first pipe and creating an annular ; wherein said first pipe and said second pipe are arranged such that the end of the second pipe is located in the vicinity of the zone ; (3) pumping a first material via the annular of the first pipe; (4) pumping a second material via the second pipe, wherein said first material and said second material create a solid foam when in contact; and (5) creating said solid foam in the vicinity of the zone such that the lost circulation be cured.

[0006] Preferably, the first pipe and the second pipe are arranged such that the end of the first pipe is located in the vicinity of the zone. In another preferred embodiment, the first pipe and the second pipe are concentric. In this way, the volume of the first material can be known exactly; and the pumping of the first material is made easily. Preferably, the solid foam is a polyurethane foam. Plugging loss zone with polymer foam is an

inexpensive process and the accuracy of the foam placement is much higher when dual injection technique is used. Success rate of curing small loss circulation zones like fissures, small cracks is high compared to severe or total loss circulation zones. One of the important reasons is the lack of exact diagnosis of the loss zone. So, the first material is a composition of polyisocyanante and polyol and the second material is a composition based on water. In dual injection, two fluids are simultaneously pumped downhole from two separate conduits. Issocyanate with polyols and water are pumped downhole through drillbit and annulus respectively. The reaction between these chemicals forms a polyurethane and carbon dioxide gas.

[0007] In a first embodiment, the first pipe is a casing and/or the second pipe is a drill pipe or a coiled tubing. In a second embodiment, the first pipe is a drill pipe, and/or the second pipe is coiled tubing. In another embodiment, the first pipe is a coiled tubing and the second pipe is a coiled tubing. The dual injection technique is easy and cheap. One of the methods is when the loss zone observed, pull the drill bit up to a certain position and pump the chemicals downhole from tubing and annulus. This treatment mainly concerns total losses when there are no returns and one of the chemicals can be pumped from an annulus. Open-ended dual injection might not be effective for various reasons and mixing of two chemicals downhole is one of them.

[0008] Ina one embodiment, the step (1) of placing a first pipe in the wellbore is done by placing said first pipe in a drill pipe. In a second embodiment, the step (1) of placing a first pipe in the wellbore is done by placing said first pipe in a casing.

[0009] Preferably, the method further comprises the step of pre-mixing the first material to enhance further mixing of first and second material.

[0010] In another aspect of the invention, a device for use in the precedent methods is described, the device comprises a tubular able to be mounted on a fourth pipe, a bowspring type element to keep said fourth pipe in the center of a third pipe wherein said bowspring type element is mounted on the tubular, a spinner able to be rotated and to mix a material wherein said spinner is mounted on a support. Advantageously, the spinner is located between the bowspring type element and the tubular, in this way when the

bowspring type element is expanded and touches the third pipe, the spinner is still able to rotate in the annular form by the third and the fourth pipe.

[0011] Preferably, several spinners are located on the support. And in the preferred embodiment, the fourth pipe is the second pipe, the third pipe is the first pipe and the material is the first material.

Brief description of the drawings

[0012] Further embodiments of the present invention can be understood with the appended drawings:

- Figure 1 shows a schematic diagram illustrating the method according to the invention in a first embodiment.
- Figure 2 shows a schematic diagram illustrating the method according to the invention in the first embodiment with a modified head.
- Figure 3 shows a schematic diagram illustrating the method according to the invention in a second embodiment.
- Figure 4 shows a schematic diagram illustrating the method according to the invention in the second embodiment with a modified head.
- Figure 5 shows a schematic diagram illustrating a device used in the methods according to the invention.

Detailed description

[0013] The present invention combines two techniques in a tailored way of curing lost circulation problem while drilling. The first one is the dual injection and the other is the use of polyurethane foam. Both techniques have been optimized by their effectiveness as far as operation and chemistry part is concerned to cure lost circulation problems.

[0014] According to a first embodiment shown on Figure 1, the method to cure lost circulation involves first dual injection technique. This dual injection technique includes inflatable packer, sensors for downhole temperature, and pressure measurements in real time. In a wellbore 1, a zone 5 to be treated is defined; this zone contains a lost circulation problem. A first pipe 10 is lowered in the wellbore, and also a second pipe 20 is lowered into this first pipe. The first pipe and the second pipe create an annular 2 between the both structures of the pipes. According to this first embodiment, the first pipe is embodied as a casing, so this technique applies to a cased hole when completion completed or in progress. And the second pipe is a drill pipe drilling the formation. In this configuration, the lost circulation problem occurs during drilling and can be treat directly with the drill pipe in an easy and quick way. The drill pipe contains an end 21 and when treatment of the zone 5 is needed, is located in the vicinity of said zone.

[0015] Advantageously, the drill pipe contains a drill bit head with nozzles (not shown on drawings). These drill bit nozzles will form jets having various directions when a fluid will flow through them. Effectively, one of the issues of open-ended dual injection technique is control over fluids mixing downhole and their effective mixing. The downhole mixing in conventional dual injection is not very well controlled and this may not give the desired results of setting/gelation upon mixing. To enhance the fluids mixing downhole, drill bit can be used. The drill bit nozzles will form jets of the low viscosity chemicals flowing through it.

[0016] Treatment of the zone will be done thanks to a polyurethane foam 52 produced from reacting polyisocyanates, polyol, (called the first material) on one side and a carrier fluid (called the second material), as for example water as reactive foaming agent on the other side. A catalyst can also be used to increase the rate of reaction. The reaction of water with polyisocyanate compound forms polyurethane foam and carbon dioxide. Polyisocyanate compound and polyol mixture is prepared in a batch tank depending on the volume to be pumped. Total losses can have no returns from the annular (or annulus) so the mixture of polyisocyanate and polyol is pumped through the annulus. The blowing agent in the system i.e. water is pumped through the drill pipe. Due to low viscosity of water, it will form jets while coming out of the drill bit nozzles. The

flow rate at tubing and annular side is maintained so that the two reacting fluids will meet each other downhole around same time. One of the reacting fluids from drill bit will enhance the mixing of the two fluids and the efficiency of mixing will increase. At the end of the drill bit, the polyurethane foam will be formed creating a solid mass that will shut down the lost circulation through the aforementioned zone.

[0017] As said, polyurethane foam can be prepared by reacting polyisocyanate compound and polyol in the presence of a foaming agent, could be water. However, other types of components can be use: examples of polyol are ethylene glycol, diethylene glycol, propylene glycol, dipropylene glycol, glycerol etc.

[0018] Polymer foam can form high-density plugs when sufficient polyurethane is used. This technique allows a train of treatments to use. A series of predetermined volume of reacting chemicals can be pumped downhole. The train of polymer foam with the variable density can make sufficiently rigid plug to cure the loss zone. However, the geometry of the loss zone is mostly unknown, so most of the times same treatment has to be repeated to cure the lost circulation. The expansion of the polymer into the form of foam covers larger area of the lost circulation zone. The polymer foam itself can be good enough to cure the losses, but it can also create a base for the second treatment e.g. denser polymer foam, loss circulation pills, or cement plug etc.

[0019] One of the advantages of the method is possible incorporation of fibers in one of the chemicals. Micron size glass fibers and/or swellable material can be incorporated to increase uniformity and well-defined crosslinked structure of the polyurethane foam. The glass fibers and/or swellable material can form screens or rigorous entanglement within their structure helping the polymer foam to improve its physical properties to some extent.

[0020] When lost circulation is observed while drilling immediate actions are taken to cure the problem. If the loss circulation treatment incorporates drill bit, then the operational feasibility is superior to other treatment methods, but it still might have some issues and one of them is downhole mixing of two chemicals. Dual injection with open-ended work string might not be effective for downhole mixing, as both the fluids come

down the in same direction and they only meet each other at the end of the tubing. Spacer can be pumped through the tubing and the annulus to avoid the chances of channeling one of the fluids in the already present drilling fluid in the wellbore. Even there is a possibility of some of the annular fluid entering the thief zone without reacting the tubing fluid. According to another embodiment of the invention shown on Figure 2, it is proposed that a simple mechanical tool or a pipe joint, which can provide upward jets of the tubing side fluid, replaces the drill bit. The tool is a simple section of a pipe connected to the drill pipe and that has angular nozzles 101 all around its periphery to direct the flow of fluid in upward direction. The length of the tool can be altered and depends on the amount of the volumes of fluids to be pumped and mixed. The upward direction of the fluid coming out from the tubing can mix with the fluid pumped through the annulus. To improve the downhole mixing angular nozzles or slots are incorporated at the end of the tubing. Tubular fluid flowing in upward jets will enhance the downhole mixing. Angular slots will form jetting of the tubing fluid in different upward directions that will improve the mixing between the tubing fluid and the annular fluid at the end of the tubing string. Excess volumes can be pumped from the tubing and the annulus to make sure that sufficient volume has been pumped downhole.

[0021] According to a second embodiment shown on Figure 3, the method to cure lost circulation involves also first dual injection technique but in another configuration. In a wellbore 1, a zone 5 to be treated is defined; this zone contains a lost circulation problem. A first pipe 10 is lowered in the wellbore, and also a second pipe 20 is lowered into this first pipe. The first pipe and the second pipe create an annular 2 (or annulus as defined below) between the both structures of the pipes. According to this second embodiment, the first and the second pipes are embodied as coiled tubings, so this technique applies to a cased hole when completion completed or in progress, but also to an open hole. In this configuration, the lost circulation problem occurs during drilling (when coiled tubing drilling (CTD) is used) or during completion steps or during testing steps. In this second configuration, the method can apply also to treat directly with the drill coiled tubing in an easy and quick way or directly with the coiled tubing also in an easy, adjustable and rapid way. The first pipe contains an end 11 and the second pipe contains an end 21; and when treatment of the zone 5 is needed, those both end (11, 21)

are located in the vicinity of said zone. Advantageously, those both pipes are concentrical helping in this way to define the volume of fluids to pump downhole. Effectively, concentric coiled tubing strings are more favorable as the exact area of tubing and annulus are known. Treatment of the zone will be done thanks to a polyurethane foam 52 produced from reacting polyisocyanates, polyol, (called the first material) on one side and a carrier fluid (called the second material), as for example water as reactive foaming agent on the other side. The mixture of polyisocyanate compound and polyol can be pumped through the outside tubing and the blowing agent can be pumped through the annulus 2 i.e. area between outside diameter of the second pipe (inner string) and inside diameter of the first pipe (outer string) of two concentric coil tubing strings. At the end of the pipes, the polyurethane foam will be formed creating a solid mass that will shut down the lost circulation through the aforementioned zone.

[0022] According to another embodiment of the invention shown on Figure 4, it is proposed that a simple mechanical tool or a pipe joint, which can provide upward jets of the tubing side fluid, replaces the concentric coiled tubing. The tool is a simple section of a pipe connected to the both coiled tubings and that has angular nozzles 102 all around its periphery to direct the flow of fluid in upward direction. The length of the tool can be altered and depends on the amount of the volumes of fluids to be pumped and mixed. A part of the nozzles is in communication with the interior of the second pipe and another part of the nozzles is in communication with the annulus. In this way, the upward direction of the fluid coming out from the second pipe can mix with the fluid pumped through the annulus at the exit of the nozzles. To improve the downhole mixing angular nozzles or slots are incorporated at the end of the coiled tubings. Tubular fluid flowing in upward jets will enhance the downhole mixing. Angular slots will form jetting of the tubing fluid in different upward directions that will improve the mixing between the tubing fluid and the annular fluid at the end of the coiled tubing. Excess volumes can be pumped from the second pipe and the annulus to make sure that sufficient volume has been pumped downhole.

[0023] According to another embodiment of the method, it could be possible to run the second pipe embodied as a coiled tubing directly through the first pipe embodied as a

drill pipe once the losses are seen while drilling. This technique can overcome issue of fluid materials to be pumped. The two materials that are mixed downhole can be pumped through drill bit to the loss zone. The two materials that are pumped downhole react with each other and form a strong gel within minutes. A polymer and a cross linker or a cement slurry and an activator can be also be pumped between the annulus and tubing sides to get the fast gelling/setting of the mixed fluids downhole. Fast setting/gelation is mandatory to cure loss circulation problem. The two fluids that are pumped downhole react with each other and form a strong gel within minutes.

[0024] According to another aspect of the invention, a device 8 shown on Figure 5 is proposed to be used in methods described above. The device 8 comprises a tubular 82 able to be mounted on the second pipe 20, which can be a coiled tubing, a tubing or a drill pipe. The device 8 comprises further a bowspring type element 83 able to keep the second pipe 20 in the center of the first pipe 10, which can be a coiled tubing, a tubing, a drill pipe or a casing. The bowspring type element 83 is mounted on the tubular 82. And the device comprises further a spinner 9A mounted on a support 84 and able to be rotated and to mix the first material 12. Preferably, several spinners (9A, 9B, 9C) are located on the support 84. In a first embodiment, the spinners are passive spinners, i.e. they are mounted on an axis and are able to rotate around this axis freely when simulated by a flow flowing across those spinners. This type of embodiment is quite useful in wells where flow can be directed through a pipe, and consequently simulate those spinners easily. The effect is an enhancement of the mixing process made by the transformation thanks to the spinners of a laminar flow to a turbulent flow. In a second embodiment, the spinners are active spinners, i.e. they are mounted on an axis and are able to rotate around this axis thanks to a miniaturized motor. Advantageously the motors are connected to a control center which can be either directly connected to the surface or connected to a sensor. The sensor can so activate the motor when detecting a particular change, for example the presence of the second material. This type of embodiment is quite useful in wells where an active mixing is needed anyway due to the architecture of the well or due to the type of materials that are mixed. In a preferred embodiment, the bowspring type element 83 is made of a metallic material and has a bowspring profile; the tubular 82 is a hinged collar to secure device 8 on the second pipe; and/or the support 84 is mounted on

the tubular or on the bowspring type element. In another preferred embodiment, the support 84 is also a bowspring type element.

[0025] In another embodiment the device can also, be a tubular 82 able to be mounted on any type of pipe 200. The device 8 comprises always a bowspring type element 83 able to keep the pipe 200 in the center of another pipe 100. The bowspring type element 83 is mounted on the tubular 82. And the device comprises further a spinner 9A mounted on a support 84 and able to be rotated and to mix any type of material 120. As said, these spinners can be of the type that either turn with flow so give efficient cleaning while pumping. Or these spinners can be of type that can be activated with the wireline special tool, using the magnetic field post placement.

Claims

1. A method to cure lost circulation in a zone (5) of a wellbore (1), comprising the steps of:

   - placing a first pipe (10) in the wellbore;
   - placing a second pipe (20) inside said first pipe and creating an annular (2); wherein said first pipe and said second pipe are arranged such that the end of the second pipe (21) is located in the vicinity of the zone (5);
   - pumping a first material (12) via the annular of the first pipe;
   - pumping a second material (22) via the second pipe, wherein said first material and said second material create a solid foam (52) when in contact; and
   - creating said solid foam in the vicinity of the zone such that the lost circulation be cured.

2. The method of claim 1, wherein said first pipe and said second pipe are arranged such that the end of the first pipe (11) is located in the vicinity of the zone (5).

3. The method of claim 1 or 2, wherein the first pipe (10) and the second pipe (20) are concentric.

4. The method according to anyone of claims 1 to 3, wherein the solid foam (52) is a polyurethane foam.

5. The method according to anyone of claims 1 to 4, wherein the first material is a composition of polyisocyanante and polyol and the second material is a composition based on water.

6. The method according to anyone of claims 1 to 5, wherein the first pipe (10) is a casing.

7. The method according to anyone of claims 1 to 5, wherein the first pipe (10) is a drill pipe.

8. The method according to anyone of claims 1 to 5, wherein the first pipe (10) is a coiled tubing and the second pipe (20) is a coiled tubing.

9. The method according to anyone of claims 1 to 5, wherein the step of placing a first pipe (10) in the wellbore is done by placing said first pipe (10) in a drill pipe.

10. The method according to anyone of claims 1 to 5, wherein the step of placing a first pipe (10) in the wellbore is done by placing said first pipe (10) in a casing.

11. The method according to anyone of claims 1 to 10, further comprising the step of pre-mixing the first material (12).

12. Device (8) for use in the method according to claim 1 to 11, comprising a tubular (82) able to be mounted on a fourth pipe (200), a bowspring type element (83) to keep said fourth pipe in the center of a third pipe (100) wherein said bowspring type element (83) is mounted on the tubular, a spinner (9A) able to be rotated and to mix a material (220) wherein said spinner (9A) is mounted on a support (84).

13. Device of claim 12, wherein the spinner (9A) is located between the bowspring type element (83) and the tubular (82).

14. Device of claim 12 or 13, further comprising several spinners (9A, 9B, 9C).

15. Device according to anyone of claims 12 to 14, wherein the fourth pipe (200) is the second pipe (20), the third pipe (100) is the first pipe (10) and the material (220) is the first material (12).

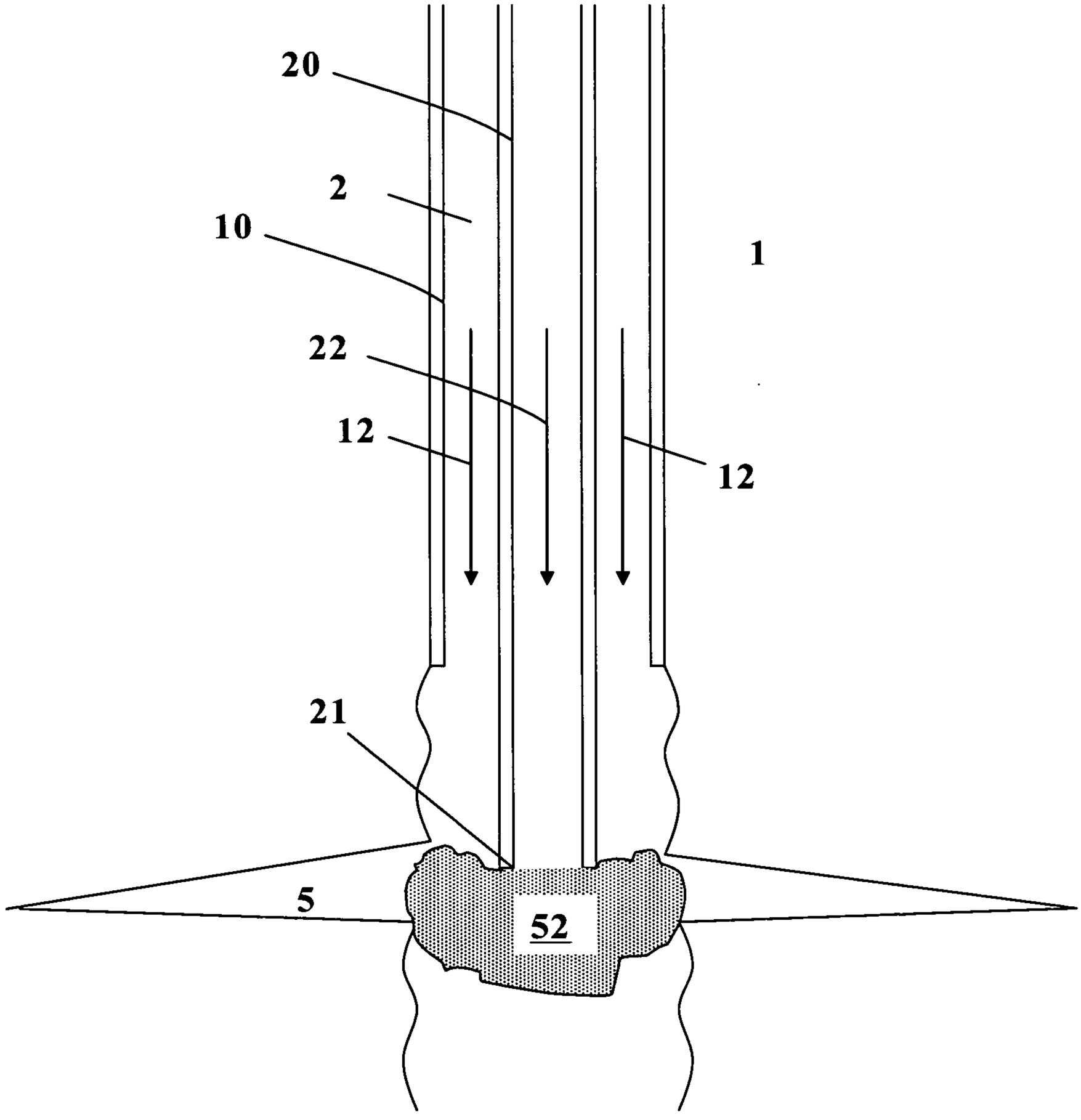


Figure 1

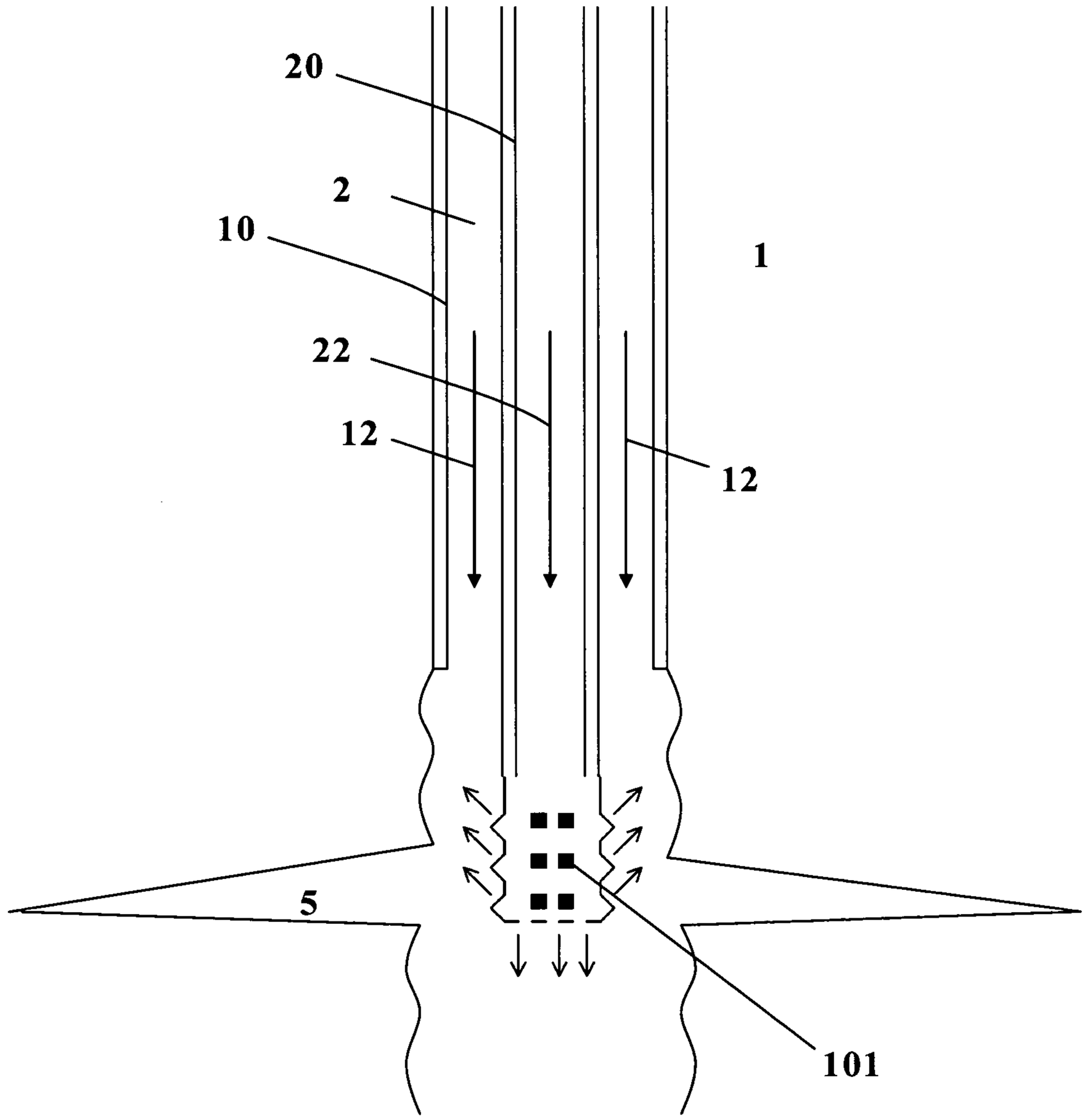


Figure 2

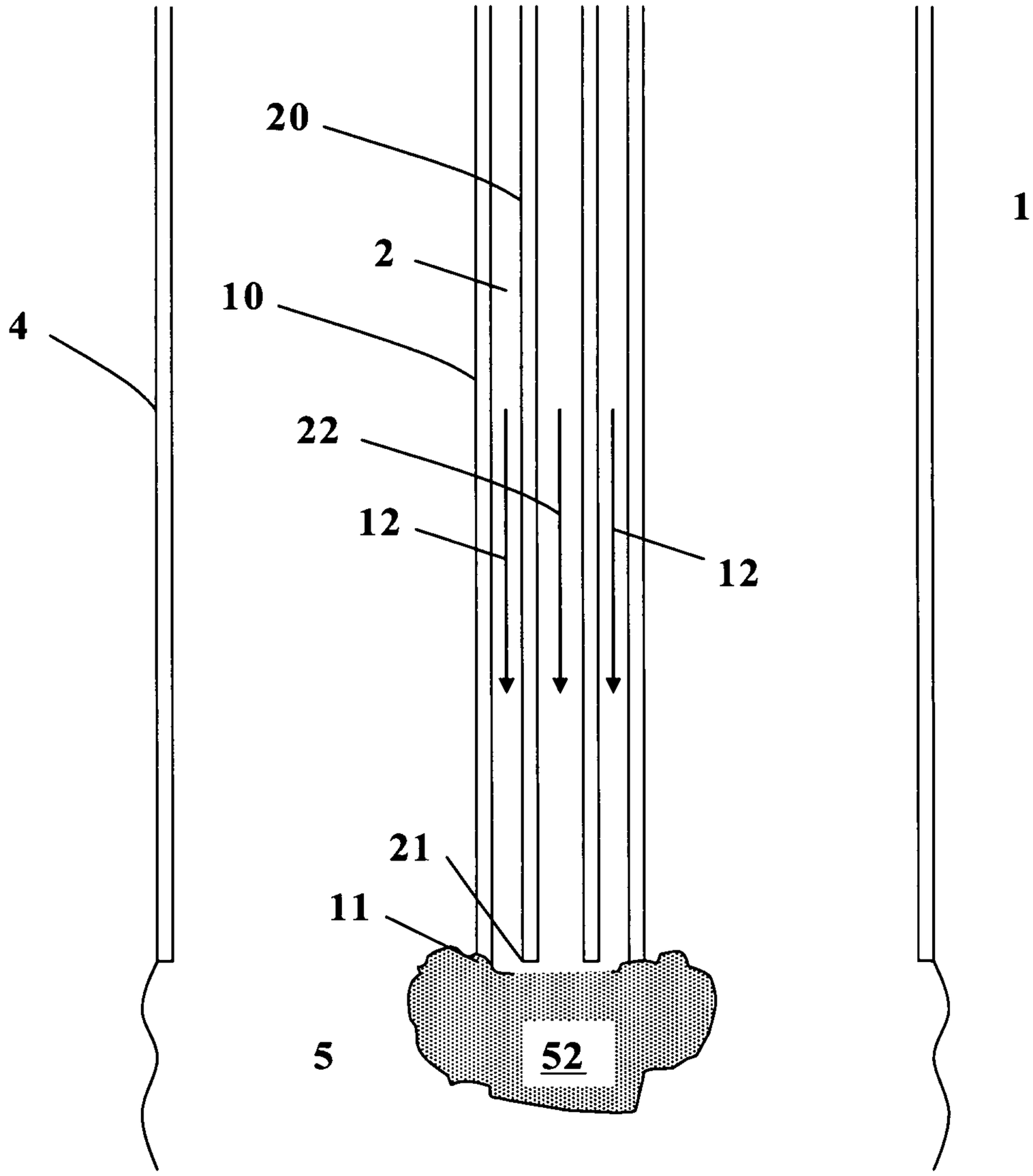


Figure 3

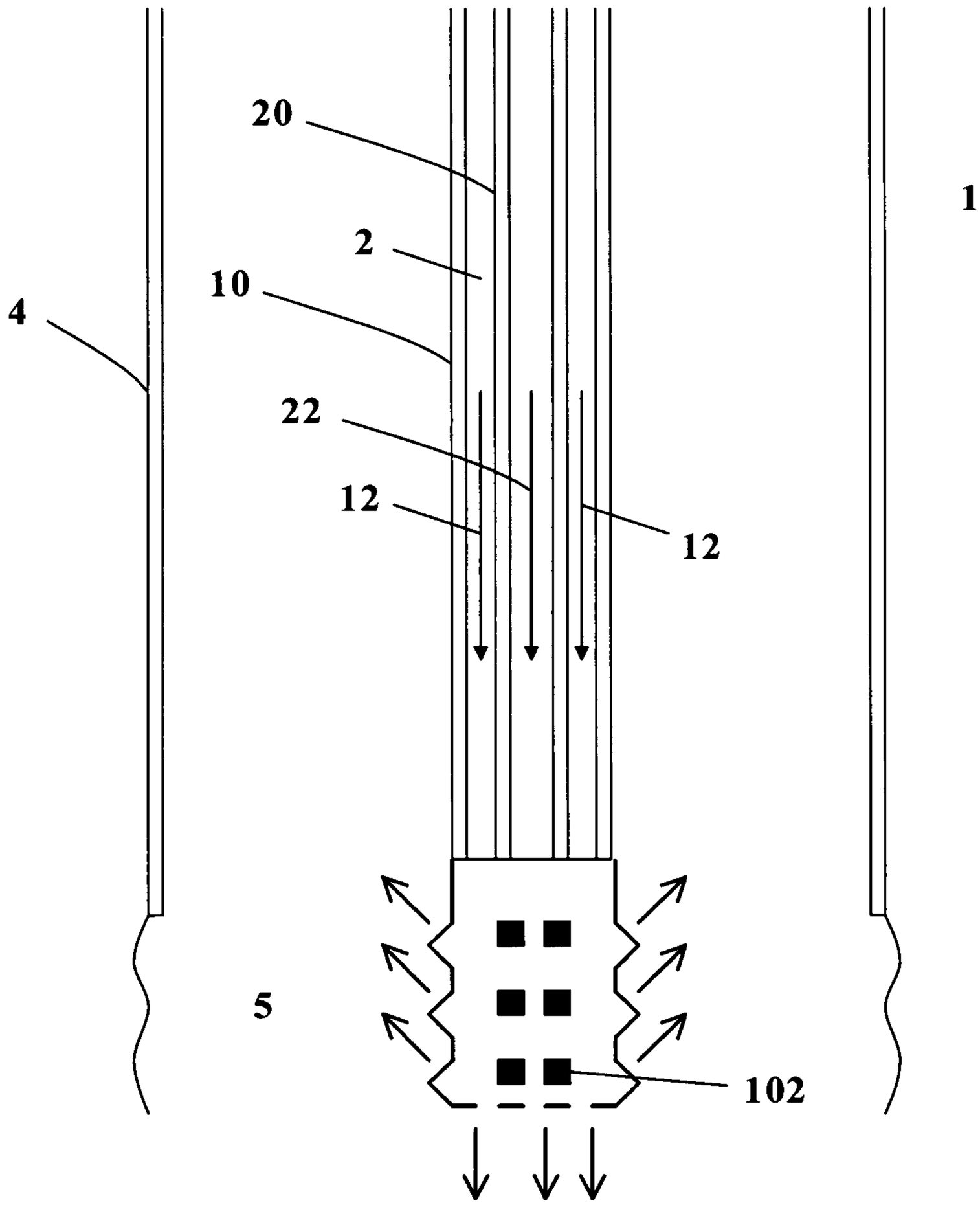


Figure 4

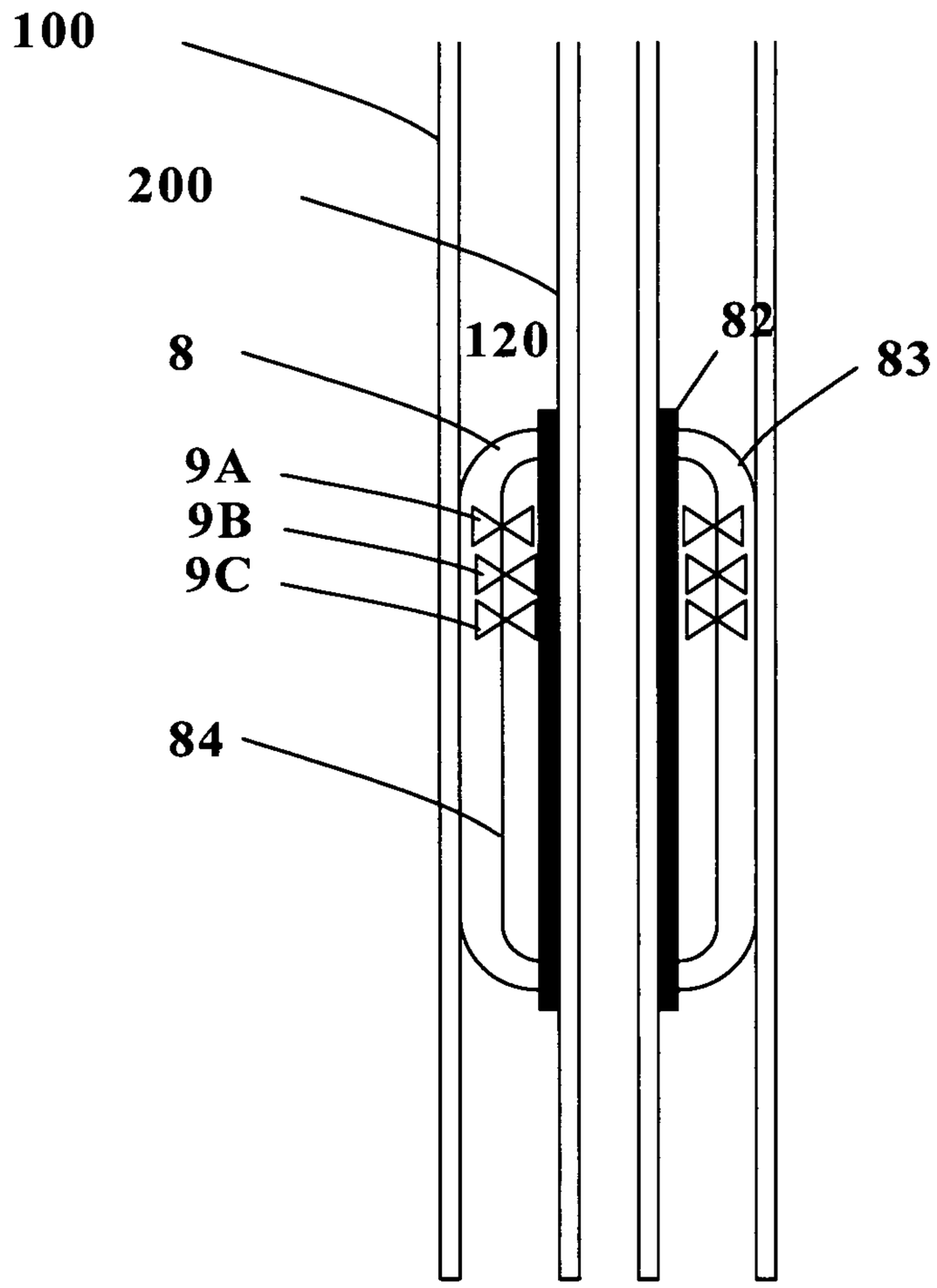
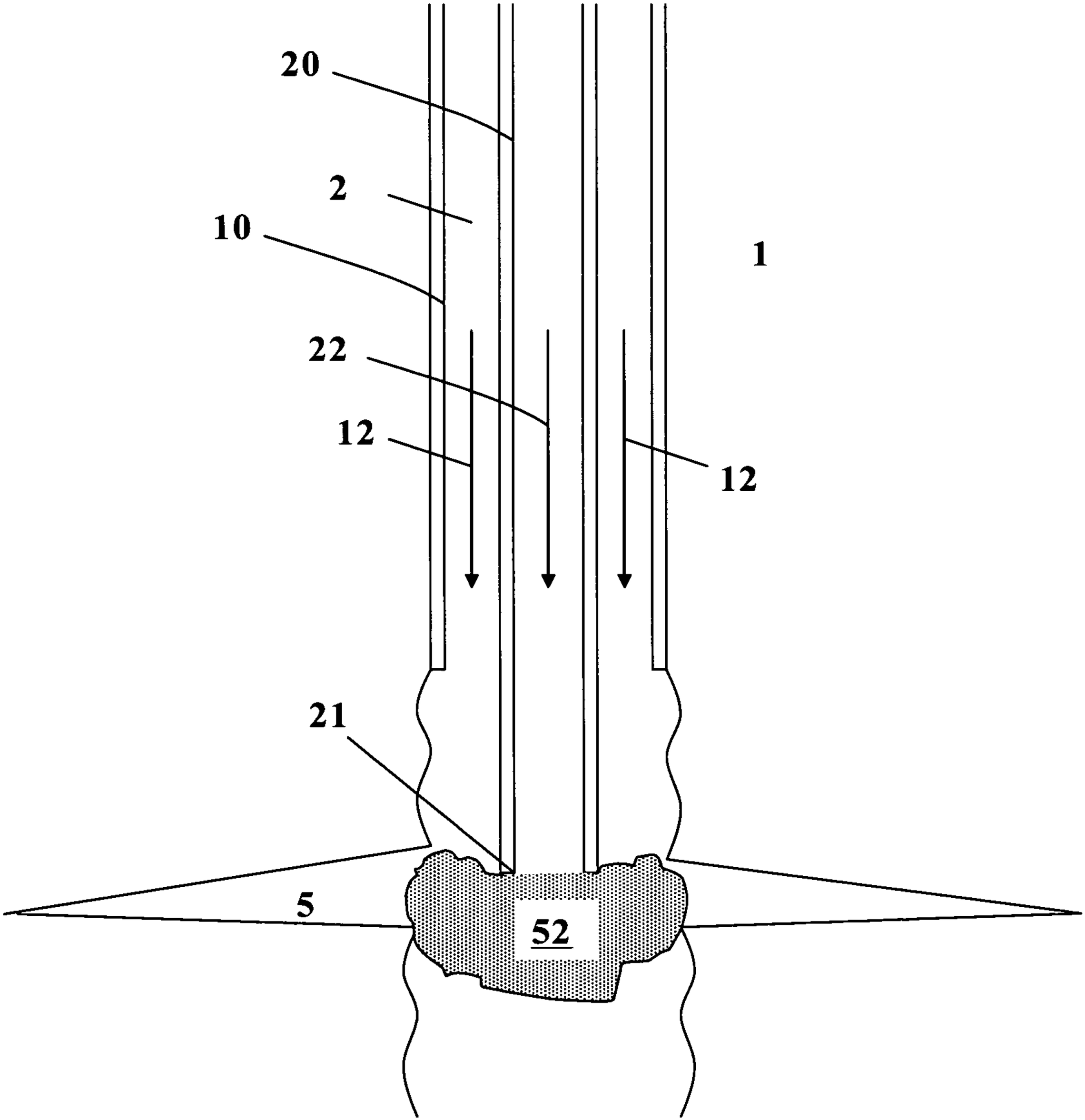


Figure 5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