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(54) **EVALUATION OF FRACTURE GEOMETRIES IN ROCK FORMATIONS**

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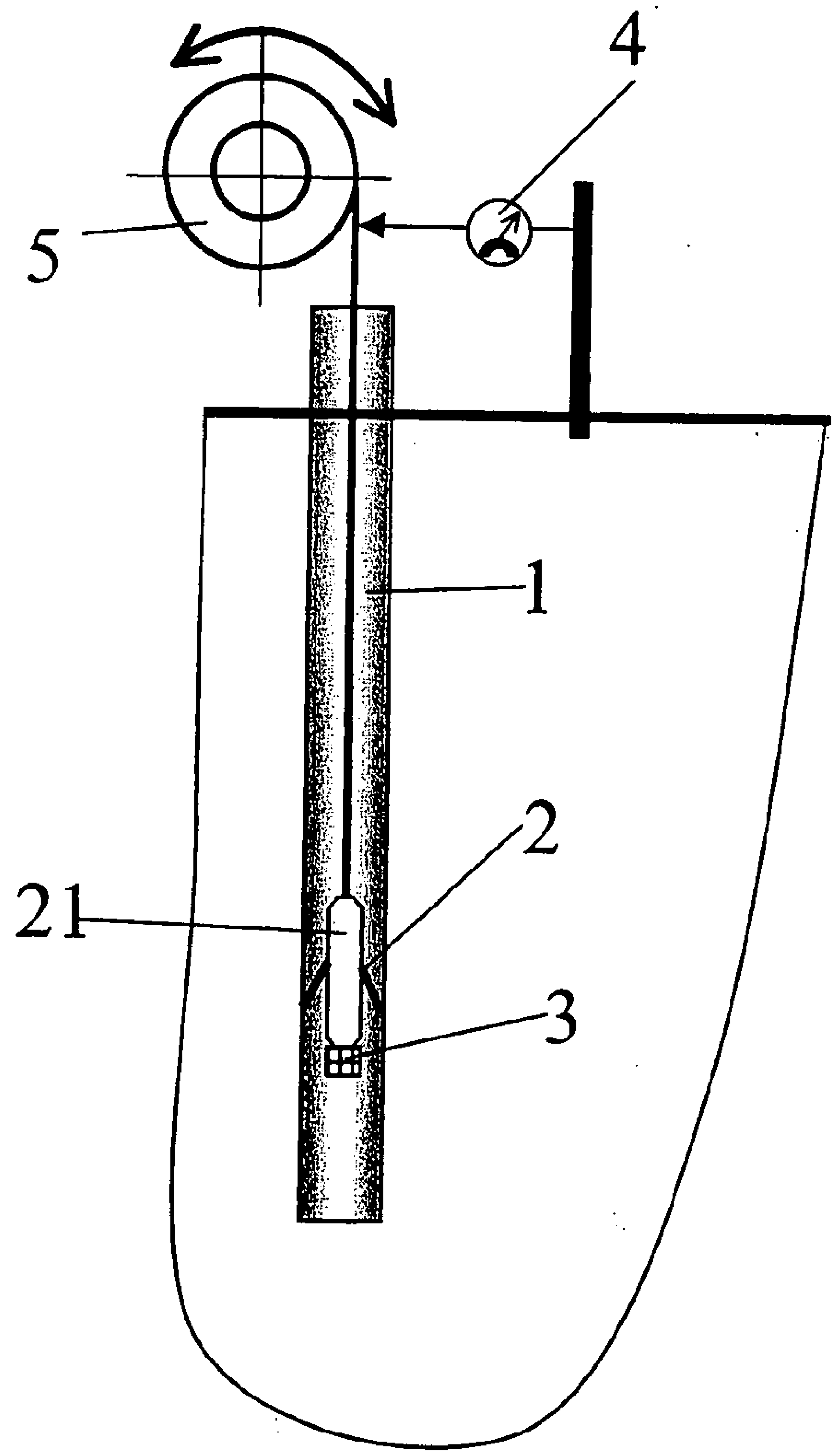
(57) **ABSTRACT**

A method of evaluating the geometry of a hydraulic fracture in a rock formation comprises the steps of:

- obtaining measured values of electric and/or magnetic fields induced by the forward or back propagation of a fracturing fluid between the fracture and the rock formation; and
- determining the geometry of the fracture from the measured values.



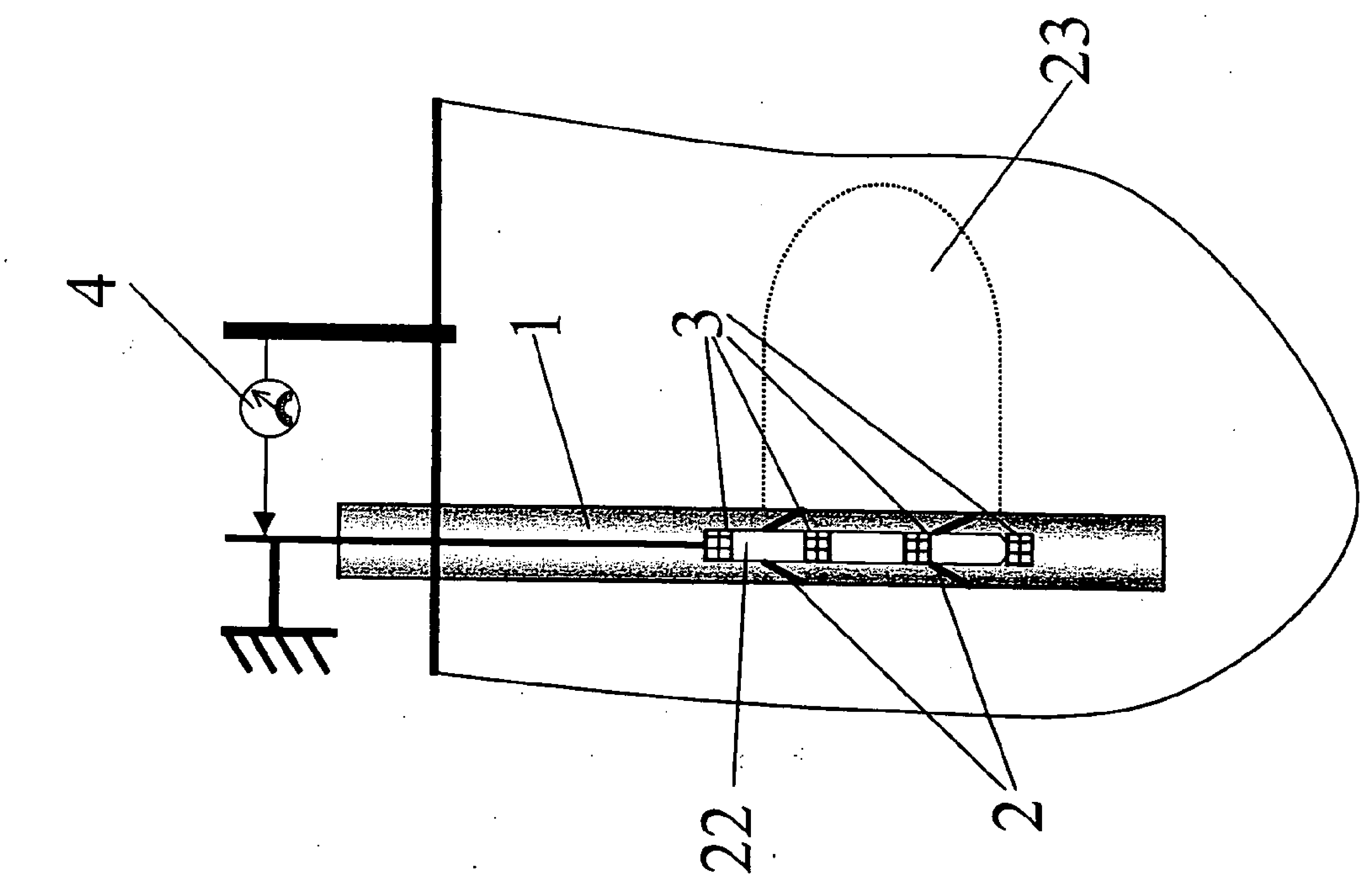


Fig.1b

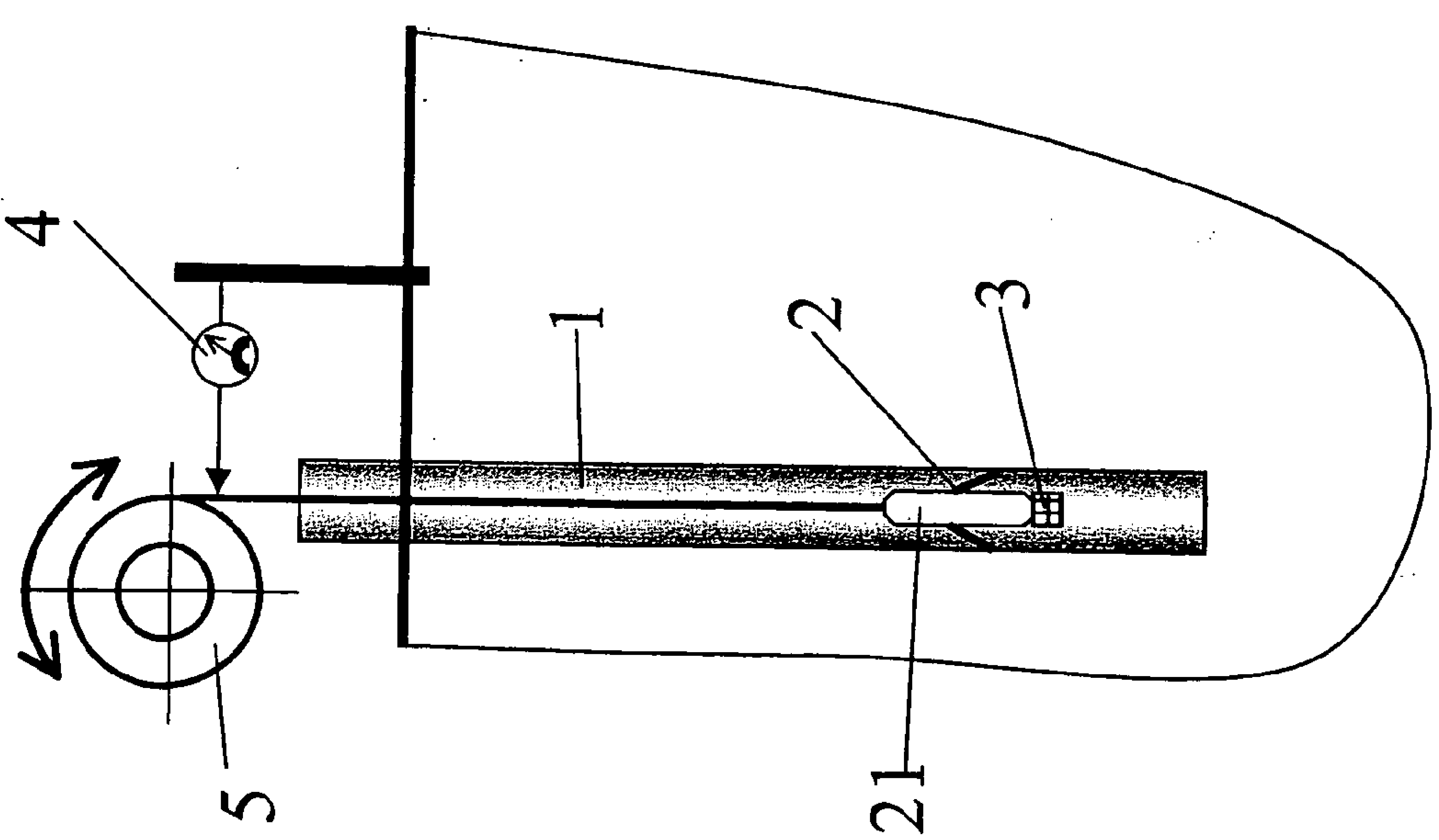


Fig.1a

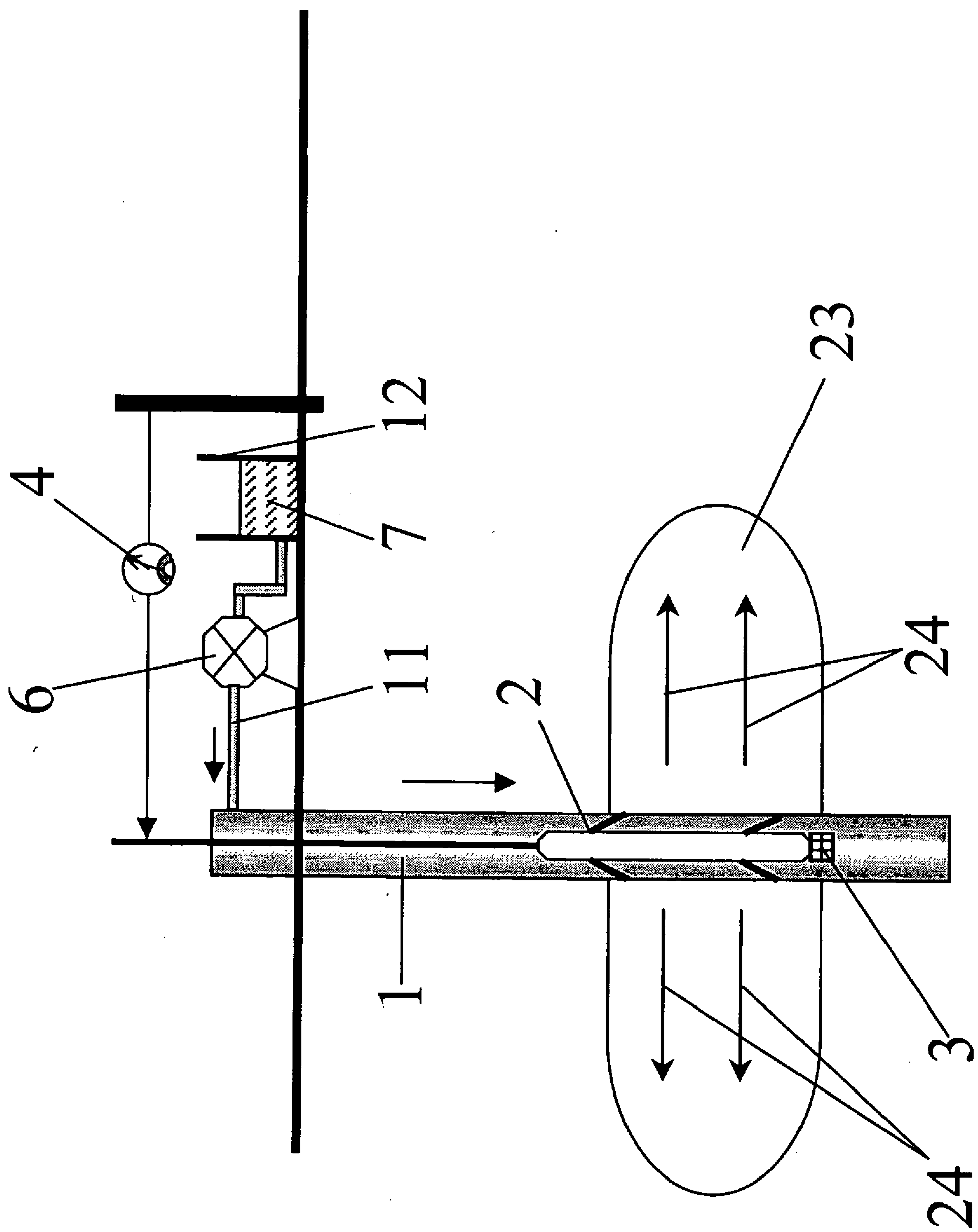


Fig.2

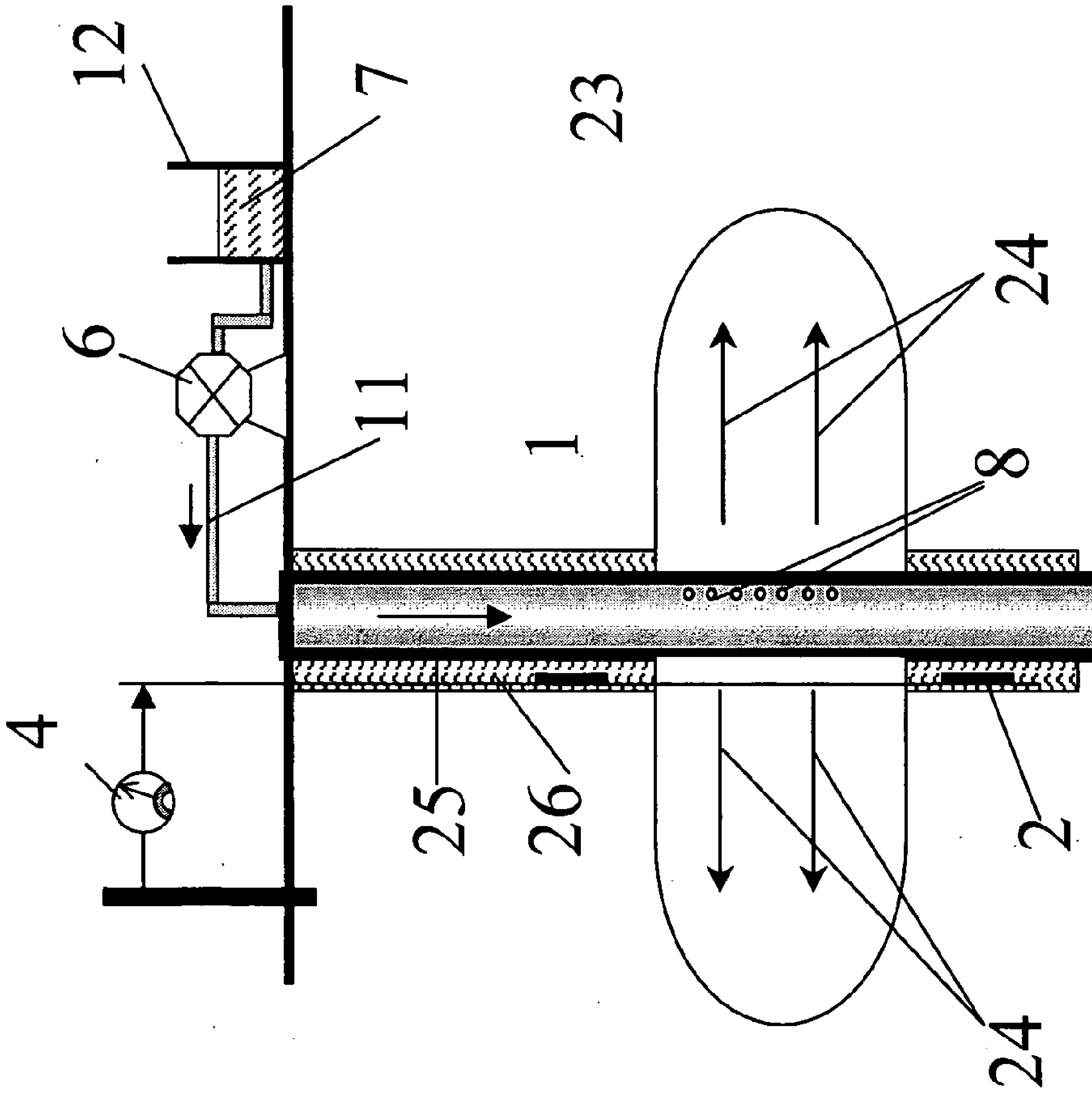


Fig.3

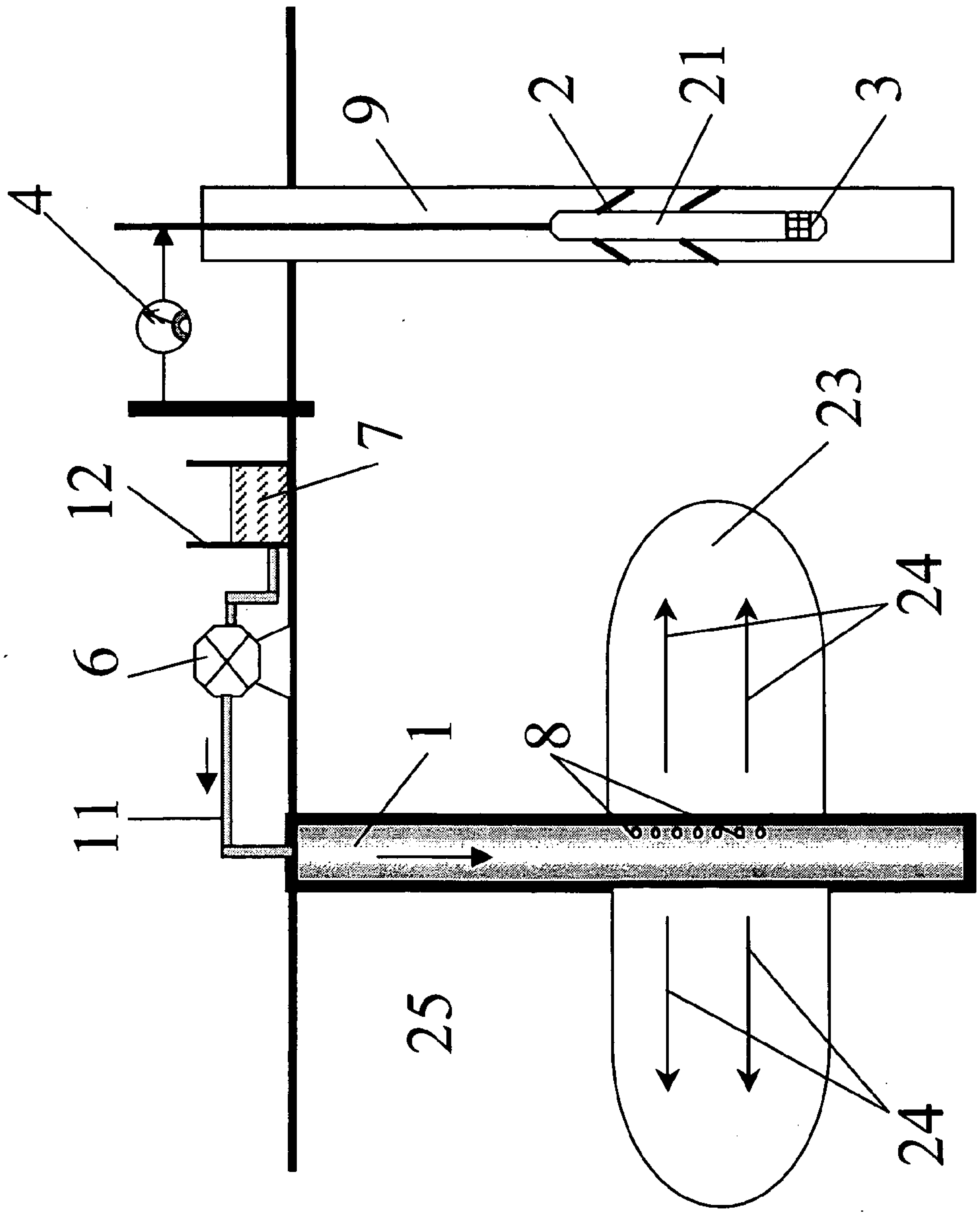


Fig.4

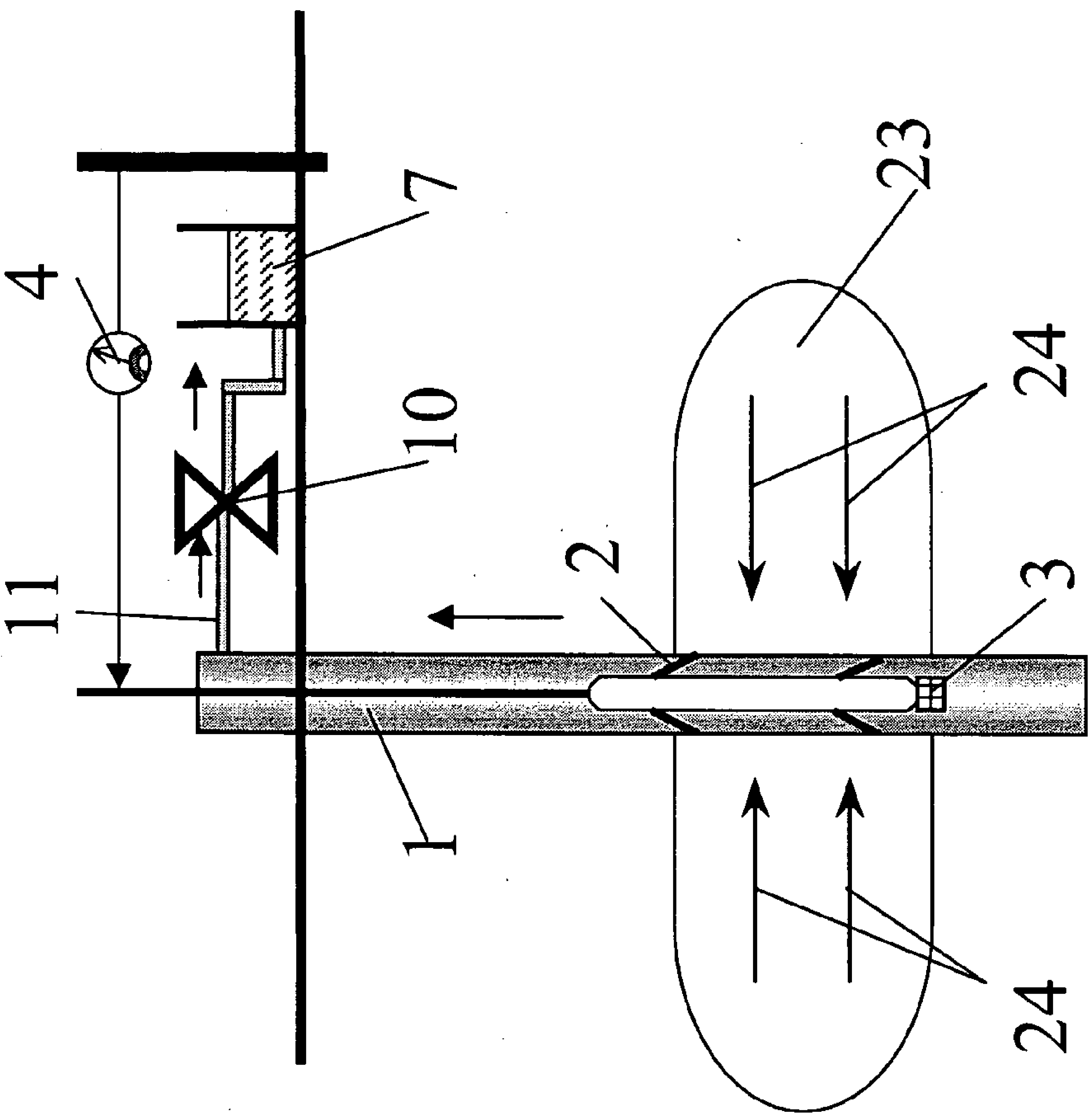


Fig.5

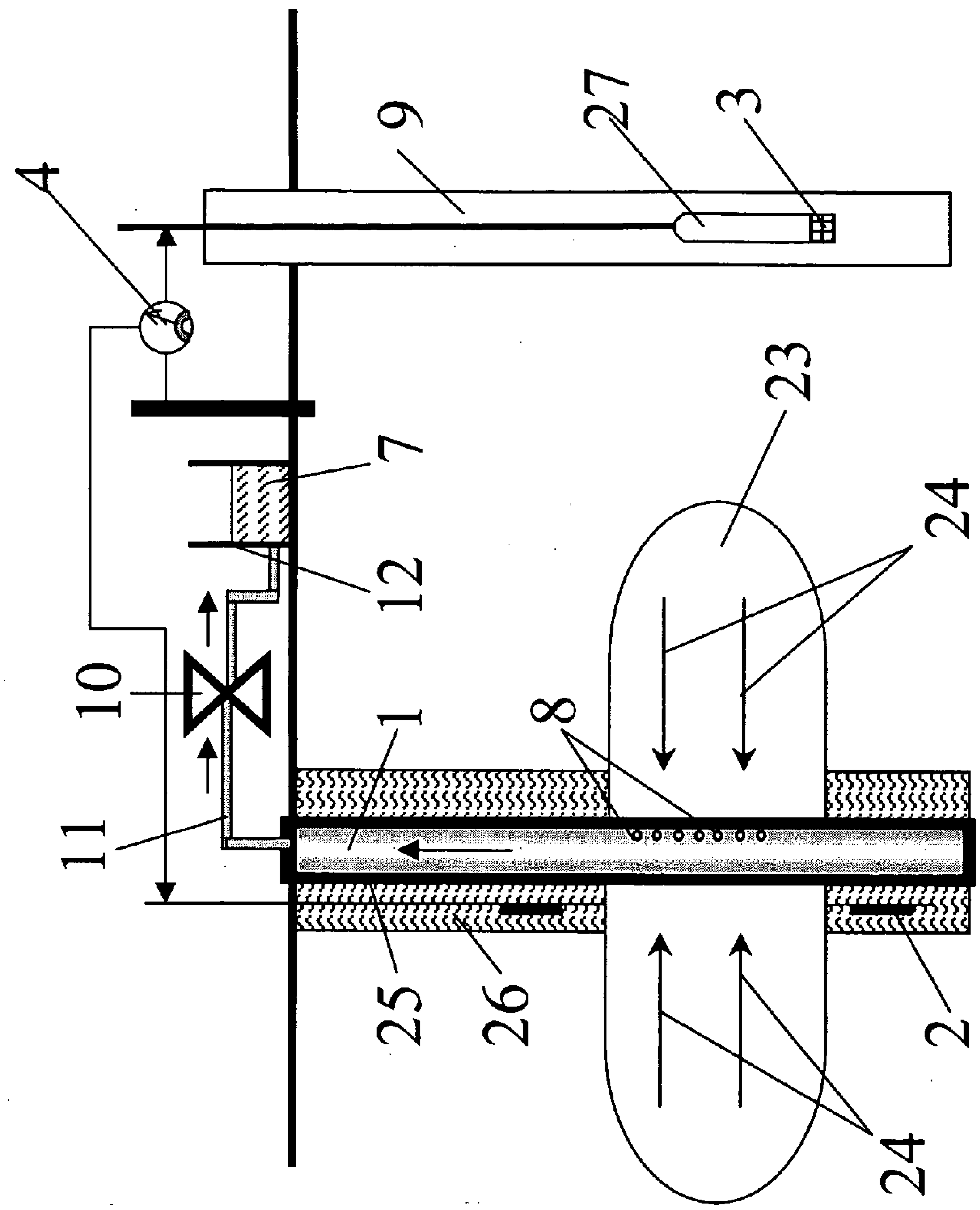


Fig.6

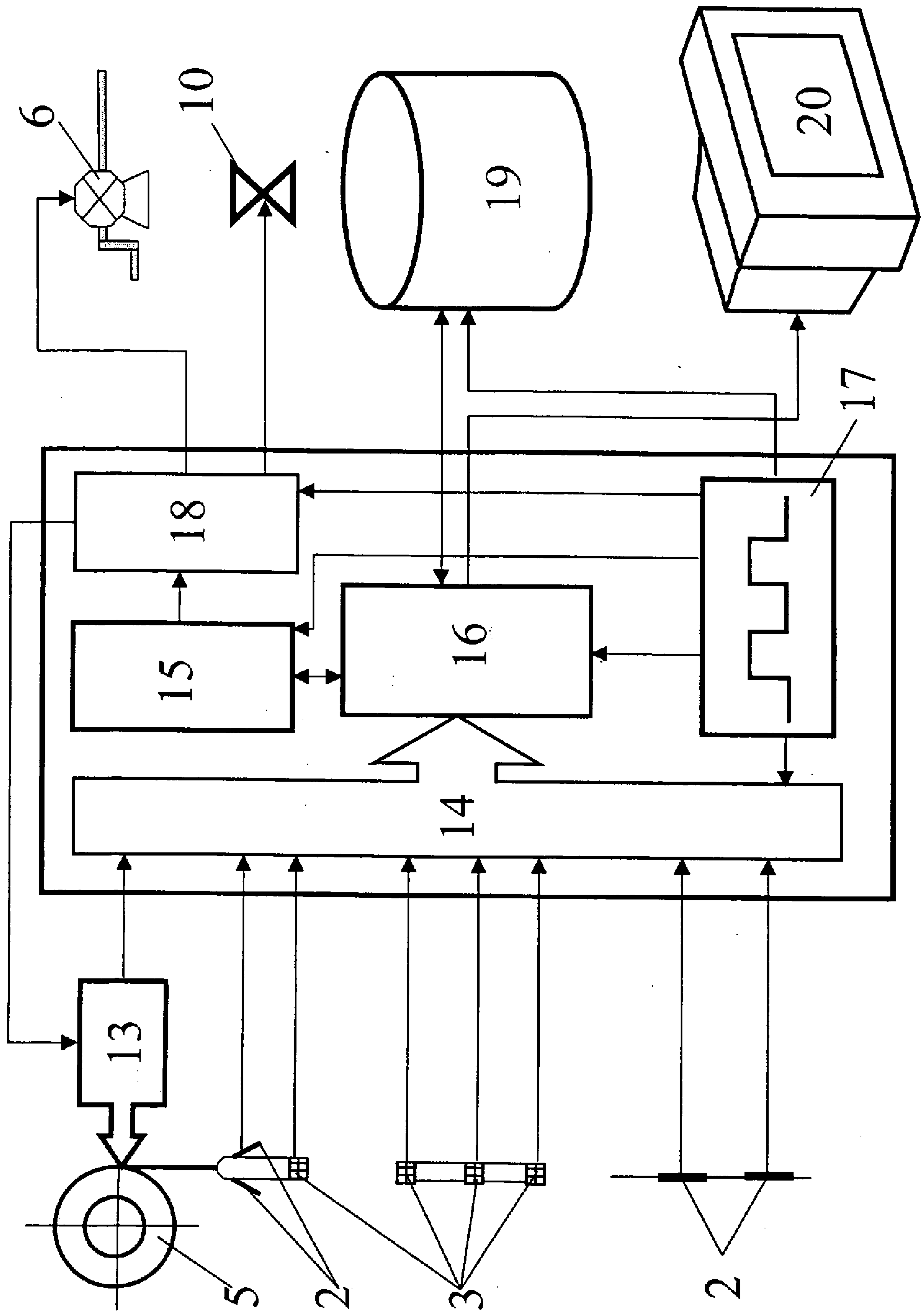


Fig.7

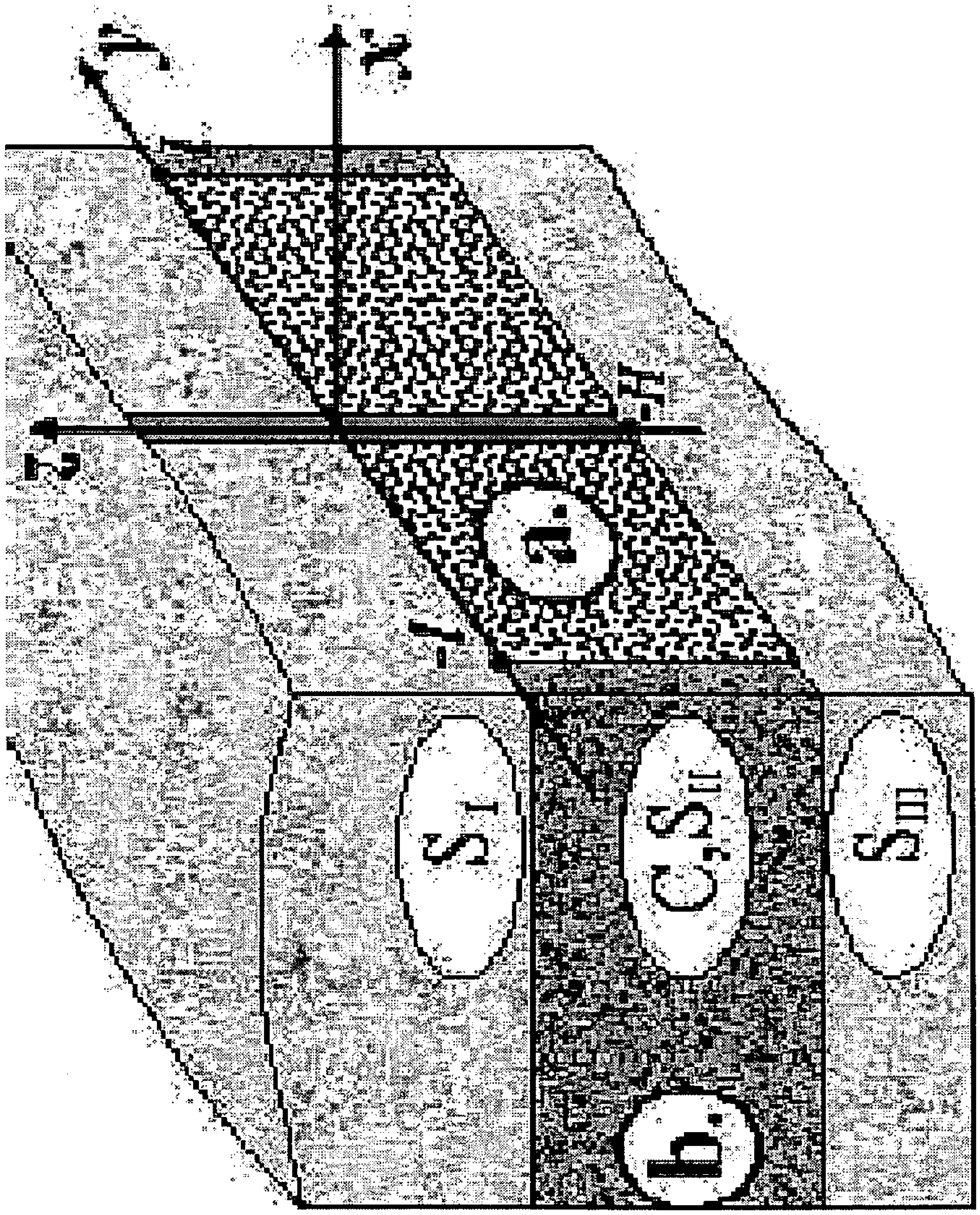


Fig.8

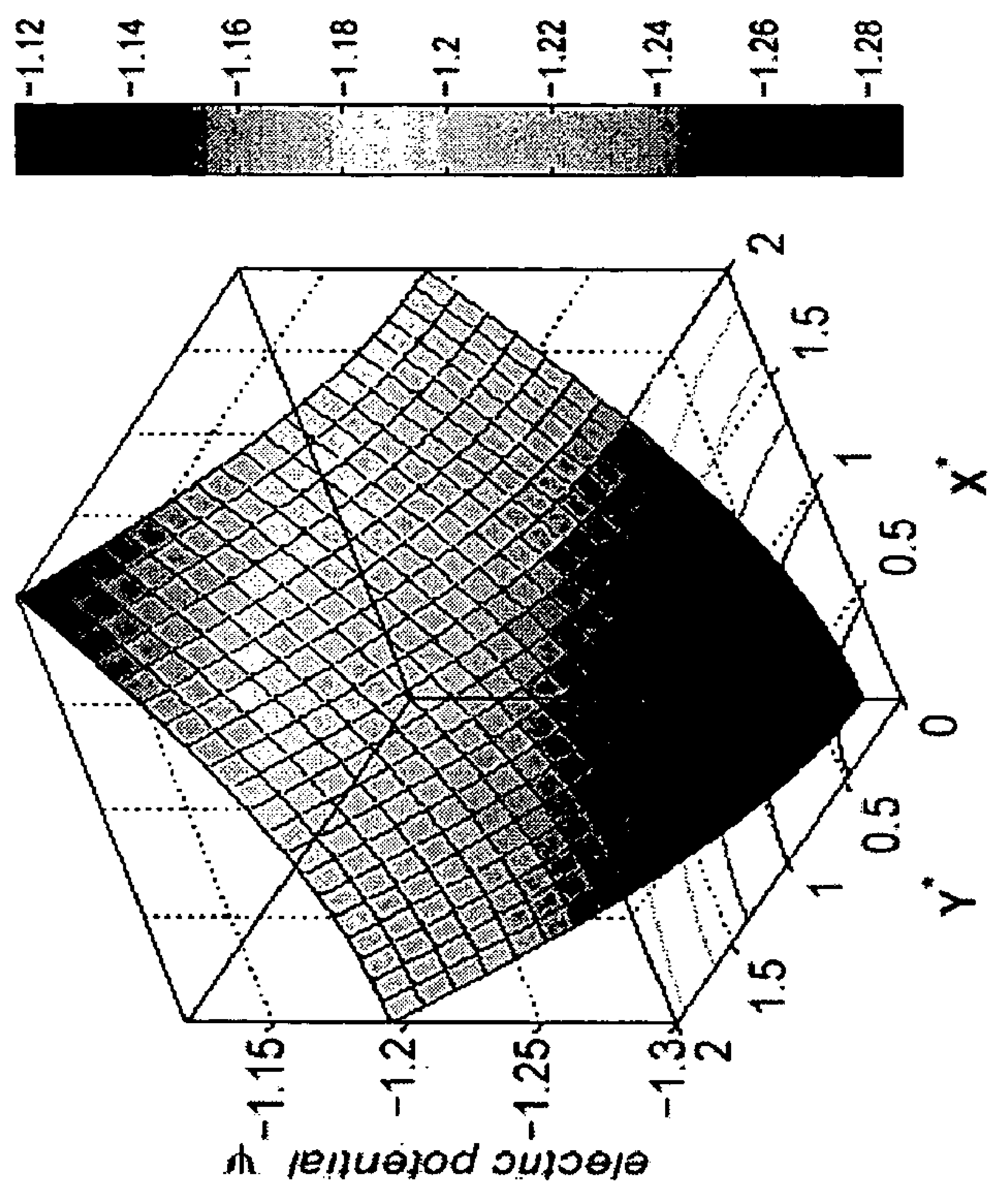


Fig.9b

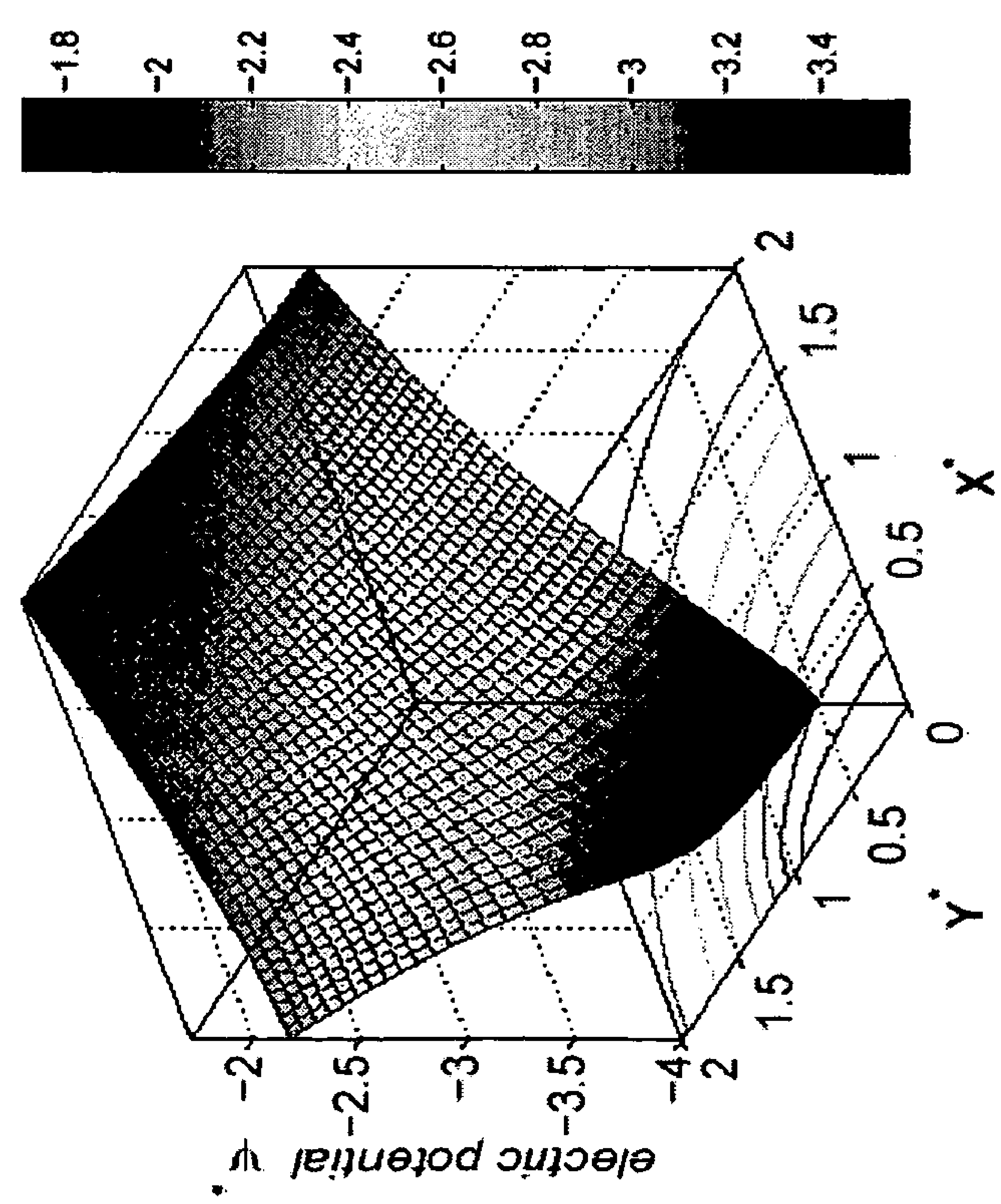


Fig.9a

EVALUATION OF FRACTURE GEOMETRIES IN ROCK FORMATIONS

FIELD OF THE INVENTION

[0001] The present invention relates to a method for evaluating the shape or geometry of hydraulic fractures in rock formations. It can be advantageously applied to determine the shapes of fractures surrounding oil well boreholes.

BACKGROUND OF THE INVENTION

[0002] Hydraulic fracturing is generally used to stimulate production of hydrocarbons from hydrocarbon wells. Hydraulic fractures are created in subterranean formations by injecting high viscosity fluid (also referred to as fracturing fluid) at a high flow rate into well boreholes. The tensile fractures thus-created can be about 100 m long. The fracturing procedure generally takes from about 30 minutes to 4 hours.

[0003] In order to create a high conductivity drain in the formation, the fracturing fluid usually contains proppants, small particles which are added to the fluid to keep the fracture open once the injection is stopped and pressure is released. These particles can be sand grain or ceramic grains. The width of the fracture during propagation is about 1 cm, and 4 mm once closed on proppant

[0004] To be efficient, the fracture should be contained within the reservoir formation and not propagate in the adjacent layers. It should also be of sufficient length and width. Evaluation of the geometry of the fracture is therefore an important step to ensure treatment optimization.

[0005] Fracture geometries can be evaluated utilizing various techniques and methodologies. The mostly widely used is a method of indirect evaluation based on analysis of a pressure response during the fracture treatment and subsequent production. The method is described, for example, in *Reservoir Stimulation,* Third Edition, M. J. Economides and K. G. Nolte (Ed.), Chichester, UK, Wiley, (2000). This approach provides, however, only very general information about fracture length and fracture width and does not provide any information about the exact fracture geometry. More reliable acoustic fracture imaging technology for field applications can be based on event location using passive acoustic emission. Such technology is described, for example, in *A practical guide to hydraulic fracture diagnostic technologies,* by D. Barree, M. K. Fisher and R. A. Woodroof, paper SPE 77442, presented at the SPE Annual Technical Conference and Exhibition held in San Antonio, Tex., USA, 28 September to Oct. 2, 2002. Acoustic emission events generated by micro-earthquakes around the fracture during hydraulic fracturing are recorded by an array of geophones or accelerators placed in adjacent boreholes. The micro-earthquakes may be caused by the high stress concentration ahead of the fracture or by the decrease of stress around the fracture following fracturing fluid leak-off into the formation. In the best cases, the events can be analyzed to provide some information about the source mechanism (energy, displacement field, stress drop, source size, etc.). However, they do not provide direct quantitative information on the main fracture. The approach is commonly used in the field and is particularly suited for the estimation of fracture azimuth and dip, but not for an accurate determination of the position of the fracture tip. Another disadvantage of the approach is that the micro-earthquakes are spread around the fracture and produce a cloud of events, which do not allow a precise determination of fracture geometry.

[0006] Yet another technique for evaluating hydraulic fracture shapes is tiltmeter mapping, also discussed in the paper by D. Barree, et al. referenced above. This technique involves monitoring the deformation pattern in the rock surrounding the fracture. An array of tiltmeters measures the gradient of the displacement (tilt) field versus time. The induced deformation field is primarily a function of fracture azimuth, dip, depth to fracture middle point and total fracture volume. The shape of the induced deformation field is almost completely independent of reservoir mechanical properties, if the rock is homogeneous, and in-situ stress state.

[0007] Disadvantages of this technique are first of all in that surface tiltmeters cannot accurately resolve fracture length and height due to the depth of the fracture below the surface. Also the measurement distance is large compared to the fracture dimensions, so there is a blurring of the fracture source edges. Although downhole tiltmeters placed in the treatment borehole can provide better information on fracture height they still cannot resolve fracture length.

[0008] The electrokinetic effect is based on the generation of electric current by fluid flow through porous media. Its primary cause is the difference in mobility of ions, some of which are fixed at the surface of the solid skeleton (matrix) of the porous medium, while dissolved counter ions can move with the pore fluid, or force it to move, if an electric field is applied.

[0009] In U.S. Pat. No. 5,519,322 the effect is used to measure the permeability of a formation surrounding a borehole by measuring the magnetic field generated by the flow of fluid injected into the formation. The permeability measured in this way provides information on the capacity of the reservoir to produce oils.

[0010] A need exists to provide approaches for evaluating shapes of hydraulic fractures in rock formations, which approaches mitigate or even exclude disadvantages and deficiencies explained above.

SUMMARY OF THE INVENTION

[0011] It is an object of the present invention to provide a method for evaluating fracture geometries in rock formations surrounding oil boreholes. An insight of the inventors was that the electrokinetic effect could be used to make such evaluations.

[0012] Thus, in general terms, the present invention provides a method of evaluating the geometry of a hydraulic fracture in a rock formation, comprising the steps of:

[0013] obtaining measured values of electric and/or magnetic fields induced by the forward or back propagation of a fracturing fluid between the fracture and the rock formation; and

[0014] determining the geometry of the fracture from the measured values, e.g. as a function of the positions and/or times of the measurements.

[0015] The term "fracture" as used herein covers a single fracture or a plurality of related fractures all caused by the same fracturing event.

[0016] In a first aspect, the present invention provides a method of evaluating the geometry of a hydraulic fracture in a rock formation, comprising the steps of:

[0017] injecting into a borehole a fracturing fluid at a pressure allowing the fluid to create a fracture in a formation surrounding the borehole and to propagate into the fracture and further into the formation through the fracture faces;

[0018] measuring downhole the values of electric and/or magnetic fields induced by the propagation of the fluid into the fracture and further into the formation; and

[0019] determining the geometry of the fracture from the measured values, e.g. as a function of the positions and/or times of the measurements.

[0020] Particular embodiments of this aspect of the present invention provide a method of evaluating a shape of hydraulic fractures in a rock formation, in which method: at least one borehole is provided; given fluid is injected into at least one of the provided boreholes at a pressure allowing the fluid to create fractures around the borehole and to propagate into the created fractures and further into the formation through fracture faces; electric and/or magnetic fields induced by the propagation of the fluid into the fractures and further into the formation through fracture faces are measured downhole; and the shape of the fractures is determined using values of either or both of the measured fields as a function of either or both of the position and time of the measurements.

[0021] In a second related aspect, the present invention provides a method of evaluating the geometry of a hydraulic fracture in a rock formation, comprising the steps of:

[0022] injecting into a borehole a fracturing fluid at a pressure allowing the fluid to create a fracture in a formation surrounding the borehole and to propagate into the fractures and further into the formation through the fracture faces;

[0023] lowering the pressure in the borehole such that the fluid propagates back from the formation into the fracture;

[0024] measuring downhole the values of electric and/or magnetic fields induced by the back propagation of the fluid from the formation into the fracture; and

[0025] determining the geometry of the fracture from the measured values, e.g. as a function of the positions and/or times of the measurements.

[0026] Particular embodiments of this aspect of the present invention provide a method of evaluating a shape of hydraulic fractures in a rock formation, in which method: at least one borehole is provided, given fluid is injected into at least one of the provided boreholes at a pressure allowing the fluid to create fractures around the borehole and propagate into the created fractures and further into the formation through fracture faces; pressure in the borehole used for the injection is lowered to a value allowing the fluid to propagate back from the formation into the fractures through the fracture faces; electric and/or magnetic fields induced by the back propagation of the fluid from the formation is measured downhole; and the shape of the fractures is determined using values of either or both of the measured fields as a function of either or both of the position and time of the measurements.

[0027] The following optional features relate to both of these aspects.

[0028] The step of measuring downhole the values of the electric and/or magnetic fields may be performed inside a further borehole or boreholes. In relation to the particular embodiments mentioned above, for at least two provided boreholes the method allows the measurement of electric or magnetic fields to be performed inside one of the provided boreholes while the fluid which induces these fields is injected into another of the provided boreholes and propagates into the fractures and further into the formation from the fracture faces around this another of the provided boreholes.

[0029] The method may further comprise the step of:

[0030] providing a model from which expected values of the electric and/or magnetic field at the positions and/or times of the measured values can be calculated for adjustable fracture geometries and injection pressures;

[0031] wherein the geometry of the fracture is determined by adjusting the model to minimize the differences between the expected and measured values. In relation to the particular embodiments mentioned above, the method may further comprise: providing a forward model of electric and/or magnetic field distributions for a given fracture shape and injection pressure by calculating such distributions as a function of a measurement position and/or time; measuring downhole the electric and/or magnetic fields at the same positions and/or times as used for providing the forward model to provide observed electric and/or magnetic field distributions; and evaluating the shape of fractures in the rock formations by minimizing errors between the forward model distribution(s) and the observed distribution(s).

[0032] A further aspect of the invention provides a computer system which is operatively configured to determine the geometry of a hydraulic fracture in a subterranean rock formation from measured values of electric and/or magnetic fields induced by the forward or back propagation of a fracturing fluid between the fracture and the rock formation.

[0033] Thus, in certain embodiments, the invention also provides an apparatus for evaluating a shape of a hydraulic fracture in a rock formation, the apparatus comprising:

[0034] a rig for injecting a fracturing fluid into a borehole at a pressure allowing the injected fluid to create a fracture and propagate into the created fracture around the borehole;

[0035] at least one downhole tool for measuring electric and/or magnetic fields induced by the propagation of said fluid into the fracture through the fracture faces and by the propagation of this fluid back into the formation from the fracture; and

[0036] a computer system according to this aspect of the invention, for determining the geometry of the fracture from the measured values of the electric and/or magnetic fields.

[0037] In certain other embodiments, the invention also provides an apparatus for evaluating a shape of a hydraulic fracture in a rock formation, the apparatus comprising means for injecting a given fluid into at least one borehole at a pressure allowing the injected fluid to create fractures and propagate into the created fractures around the borehole; at least one downhole tool for measuring electric and/or magnetic fields induced by the propagation of said fluid into the fractures and by the leaking-off of this fluid into the formation from the fracture face; and means, such as a computer system, for determining a shape of the fractures using values of either or both of the measured fields as a function of measurement position and time.

[0038] In relation to the apparatus embodiments, the or each downhole tool may be movable along the borehole. The means for injecting the given fluid may be a surface pump. The apparatus itself may further comprise: at least one memory unit for storing expected values of the electric and/or magnetic fields for a given fracture shape and injection pressure according to a measurement position and/or time; means for evaluating the location of the downhole tool in the borehole; at least one processing unit for selecting electric and/or magnetic field values measured by the downhole tool at the positions and/or times for which the values are stored in the memory unit, and for minimizing errors between the stored and selected values; and means for outputting data on the evaluated shape of the fractures in the rock formation.

[0039] Further aspects of the invention provide: (i) a computer program for determining the geometry of a hydraulic fracture in a subterranean rock formation from measured values of electric and/or magnetic fields induced by the forward or back propagation of a fracturing fluid between the fracture and the rock formation; and (ii) a computer program product carrying such a program.

BRIEF DESCRIPTION OF THE DRAWINGS

[0040] Specific embodiments of the present invention will now be described with reference to the following drawings in which:

[0041] **FIG. 1***a* is a schematic diagrams respectively showing a borehole with a movable sensor arrangement, and **FIG. 1***b* is a schematic diagram showing a borehole with a fixed sensor arrangement;

[0042] **FIG. 2** is a schematic diagram showing an embodiment according to the invention;

[0043] **FIG. 3** is a schematic diagram showing a borehole with perforated casing and cemented sensors;

[0044] **FIG. 4** is a schematic diagram showing an embodiment for two boreholes according to the invention;

[0045] **FIG. 5** is a schematic diagram showing another embodiment according to the invention;

[0046] **FIG. 6** is a schematic diagram showing yet another embodiment according to the invention;

[0047] **FIG. 7** is a block diagram of an apparatus according to one embodiment of the invention;

[0048] **FIG. 8** is a schematic diagram showing a formation comprising three layers;

[0049] **FIGS. 9***a* and *b* are three-dimensional plots showing distributions of electric potential as a function of horizontal position coordinates and depth.

DETAILED DESCRIPTION OF THE INVENTION

[0050] **FIG. 1***a* is a schematic view of a borehole **1** with a sensor arrangement (associated with a downhole tool) **21** which comprises electric field sensors **2** and magnetic field sensors **3**. The electric field sensors **2** are voltage electrodes which contact the borehole and the magnetic field sensor **3** is a magnetometer, such as a high-precision nuclear magnetic resonance device of the type provided, for example, by Schlumberger. Examples of suitable electrodes and magnetometers are described in: U.S. Pat. No. 5,642,051 and U.S. Pat. No. 6,441,618 for electrodes behind casing; EP0544583 and EP0715187 for electrodes on a wireline tool in openhole; and U.S. Pat. No. 6,597,178B1 and Etchecopar et al. (1993), *Harnessing Paleomagnetics for Logging,* Oilfield Review, October 1993, Volume 5, Number 3 for magnetometers. The sensor arrangement **21** is movable along the borehole by means of a drive **5**, thus providing measurement of electric and magnetic fields in different parts of the borehole. In this example, measurement processing means **4** is outside the borehole. The sensor arrangement comprises two voltage electrodes and one magnetic field sensor **3**, but the number of sensors may be selected depending on the particular implementation requirements.

[0051] **FIG. 1***b* shows a fixed sensor arrangement **22** which comprises a plurality of electric field sensors **2** and magnetic field sensors **3**. The number and spacing of the sensors along the borehole may be such as to provide measurements above and below the predicted positions of formation **23** boundaries. It will be apparent to those skilled in art that the locations of sensors **2** and **3** in the fixed arrangement may be adjusted as required.

[0052] An example of the invention is shown in the schematic diagram of **FIG. 2**. In addition to the sensor arrangement which is placed in the borehole **1**, the apparatus comprises pump **6** connected by channel **11** to the borehole **1**. The pump **6** is also connected to a reservoir **12** which is filled with fracturing fluid **7**. Fracturing fluid **7** may be water based or oil based, and is generally either a high viscosity (crossed-linked or uncrossed-linked) polymer fluid, or a surfactant-based fracturing fluid. The sensor arrangement may be either movable or fixed as described above. The surface pump **6** may be also be provided with a pressure controlling unit (not shown) to continuously increase or decrease the pressure in the borehole.

[0053] The pump **6** injects fluid **7** into the borehole **1** through channel **11**. Fluid **7** is injected at a pressure which is high enough to fracture the formation, whereby movement of the fluid into the borehole occurs. Fractures are create around the borehole and the fluid propagate through the faces of these fractures into formation **23** around the oil borehole. Propagation of fluid **7** into the formation is indicated schematically by arrows **24**.

[0054] Propagation of fluid **7** into the fractures and the formation induces both electric and magnetic fields which are detected by electric field sensors **2** and magnetic field sensor **3**. Measurement processing means **4** then processes the signals received from the sensors **2** and **3** to provide their output in a suitable form, i.e. as intermediate information for further processing or as final information. Output received from the processing means **4** allows evaluation of the fracture shape or geometry.

[0055] Many boreholes used for oil production are cased inside, the casing being perforated to allow produced oil to enter the borehole. Such situation is shown in **FIG. 3** where borehole **1** has casing **25** with perforations **8**. The casing can be made of different materials, but the most commonly used casing material is steel. However, to provide reliable and accurate measurements by magnetic field sensors, the magnetic field measurement should be made in an open (uncased) section of the borehole or in a cased section if the casing does not strongly disturb the magnetic field (a composite casing, for example).

[0056] It is preferable, but not essential, that the electric field is also measured in an open or non-metallic cased section of the borehole. However, if necessary the electric field can be successfully measured by sensors embedded in the cemented outer annulus **26** with which the casing is insulated, as shown in **FIG. 3**.

[0057] In situations when the casing **25** does not allow the sensor arrangement to be successfully used within the borehole, the method according to the invention can be implemented using a different borehole located near the first borehole **1**. The implementation of such a method is shown schematically in **FIG. 4**. Fracturing fluid **7** is injected by pump **6** into the borehole **1** which has casing **25** with perforations **8**. Another borehole **9**, in which is placed the sensor arrangement **21**, is located near the first borehole **1**. As described above, the sensor arrangement **21** comprises voltage electrodes **2** in contact with the borehole and a high precision magnetometer **3**. Such devices can measure the induced electric and magnetic fields up to about 100 to 500 meters from the borehole in which the fluid is injected. If necessary, a number of boreholes located around the borehole **1** within a range of about **500** meters can each be used for receiving a movable sensor arrangement **21** or a fixed arrangement **22** and obtaining corresponding measurements.

[0058] Measurable electric and magnetic fields are induced not only by the flow of pressurized injected fluid into rock formations surrounding the borehole, but also by backflow of the fracturing fluid, i.e. when it retreats into the borehole from the created fractures. This situation takes place when the pressure inside the borehole **1** is reduced, for example by means of valve **10**, to a value equal or below the pressure of the fracturing fluid **7** in the formations and fractures. This backflow is schematically shown in **FIG. 5** by the reversal of arrows **24**. Such back propagation of fluid **7** induces measurable electric and magnetic fields which can be detected by electric field sensors **2** and magnetic field sensors **3**. The signals from the sensors are supplied to measurement processing means **4** as described above with reference to **FIG. 2**.

[0059] **FIG. 6** shows schematically an example of the invention, in which the borehole **1** is cased and the casing **25** has perforations **8**. Cemented annulus **26** is provided around the casing **25** and a number of electric field sensors **2** are embedded in the annulus **26**. Magnetic field sensors **3** are attached to a sensor arrangement **27** which is either movably or fixedly located in another borehole **9** situated from the borehole **1** at a distance allowing the sensors **3** to detect the magnetic field induced by fracturing liquid flowing back from fractures into the borehole **1** when valve **10** reduces the pressure inside the borehole **1**. The signals from the sensors are supplied to measurement processing means **4** as described above with reference to **FIG. 2**.

[0060] The above examples described with references to **FIG. 1** to **6** may be implemented in various combinations, for example, a number of sensor arrangements **21** or **27** may be movably or fixedly located in boreholes surrounding the borehole **1** in which fracturing fluid **7** is injected or flowing back from the created fractures. Such combinations may allow measurements to be taken simultaneously in a ring around the borehole **1**. As an alternative, a sensor arrangement **21** or **27** can be placed sequentially in the boreholes encircling borehole **1**. In further embodiments fixed and movable sensor arrangements **21** or **27** may be located in one and the same borehole.

[0061] A general block diagram of an exemplary apparatus for implementing the method is shown in **FIG. 7**. In the exemplary apparatus, signals from sensors **2** and **3** and from drive **13** are supplied to converting unit **14**. Converting unit **14** outputs the signals in a form suitable for their further processing and storing in digital form in random-access memory (RAM) **16** and in data/program memory (DPM) **19**. DPM **19** stores programs for implementing modelling calculations. Processing unit **15** receives data from RAM **16** and performs calculations to produce output information and signals to control pump **6**, valve **10** and drive **13** by means of controlling unit **18**. Output information from processing unit **15** is stored in RAM **16** and DPM **19**. Output data may also be monitored at display unit **20**. Synchronization and internal timing for the described units is provided by a clocking unit **17**.

[0062] The method of the invention may be implemented by providing a forward model of an electric or magnetic field distribution for a given fracture shape and downhole pressure and evaluating the shape of fractures in the rock formations by minimizing errors between the forward model of electric and magnetic field distributions and the corresponding downhole measured distributions.

[0063] The forward model provides field distributions based on the following equations. The electrokinetic effect involves the generation of an electric current by fluid flow through porous media (the reverse effect involves inducing flow through the application of an electric field). Its primary cause is the difference in mobility of ions, some of which are fixed at the surface of the solid skeleton (matrix) of the porous medium, while dissolved counter ions move with the pore fluid (or force it to move, if an electric field is applied).

[0064] Macroscopically, the flow and electric current are described by the equations:

$$u = -\frac{k}{\eta_f}\nabla p + \beta\nabla\psi \tag{1}$$

$$j = -S(\nabla\psi - C\nabla p),\ C = \frac{\alpha}{S} \tag{2}$$

[0065] in which k is the reservoir permeability, η_f is the reservoir fluid conductivity, p is the fluid pressure, ψ is the electrokinetic potential, S is the rock electric conductivity, and C is the electro-kinetic coupling coefficient.

[0066] The Onsager relation holds between the coupling coefficients C and β:

$$\beta = \alpha \equiv Cs \tag{3}$$

[0067] The magnetic field generated by the flow-induced current can be evaluated generally using Biot-Savart's law. However, for the specific case considered, it is more convenient to use an expression for the magnetic induction vector B in terms of the vector potential A:

$$B=[\nabla\times A] \tag{4}$$

[0068] where the vector potential satisfies the equation (in SI units):

$$\Delta A=-\mu j \tag{5}$$

[0069] The forward model of electric field and magnetic field distributions is calculated by solving the equations above taking account of conservation laws, boundary conditions, symmetry consideration and Fourier transform used. The model cam also take into account the influence of several formation layers.

[0070] An example application is illustrated below during production from a reservoir. The formation is composed of three layers S_1, S_2 and S_3, as shown in **FIG. 8**, and the electric conductivities of the layers, which have been previously measured with conventional resistivity wireline logs, are respectively about 0.001, 0.1 and 0.001 in Siemens/m. The fracture is entirely in the reservoir (i.e. layer S_2) and is of height H and length **2**L as shown in **FIG. 8**. The following dimensionless parameters are used:

$$H^*=H/L$$

$$X^*=x/L$$

$$Y^*=y/L$$

$$Z^*=z/L \tag{6}$$

[0071] **FIGS. 9***a* and **9***b* show the expected electric potential predicted by the forward model as a function of X* and Y* at two different measurement depths (Z*). The distributions shown in these figures have characteristic lengths related to the fracture length and fracture height, and an anisotropy related to fracture direction.

[0072] The real distributions of electric and magnetic fields induced by fracturing fluid flow in the borehole and fractures are revealed by downhole measuring these fields at the same positions and times of measuring as used for calculating the forward model of the electric or magnetic field distributions. The measured distributions are also referred to as "observed electric or magnetic field distributions". The orientation, length and height of the fracture are adjusted in the forward model until minimization of the difference between the forward model values and the measured values is achieved. In this way, the orientation, length and height of the fracture can be determined.

[0073] While the invention has been described in conjunction with the exemplary embodiments described above, many equivalent modifications and variations will be apparent to those skilled in the art when given this disclosure. Accordingly, the exemplary embodiments of the invention set forth above are considered to be illustrative and not limiting. Various changes to the described embodiments may be made without departing from the spirit and scope of the invention.

[0074] All the references mentioned herein are hereby incorporated by reference.

What is claimed is:

1. A method of evaluating the geometry of a hydraulic fracture in a rock formation, comprising the steps of:

obtaining measured values of electric and/or magnetic fields induced by the forward or back propagation of a fracturing fluid between the fracture and the rock formation; and

determining the geometry of the fracture from the measured values.

2. A method of evaluating the geometry of a hydraulic fracture in a rock formation, comprising the steps of:

injecting into a borehole a fracturing fluid at a pressure allowing the fluid to create a fracture in a formation surrounding the borehole and to propagate into the fracture and further into the formation through the fracture faces;

measuring downhole the values of electric and/or magnetic fields induced by the propagation of the fluid into the fracture and further into the formation; and

determining the geometry of the fracture from the measured values.

3. A method of evaluating the geometry of a hydraulic fracture in a rock formation, comprising the steps of:

injecting into a borehole a fracturing fluid at a pressure allowing the fluid to create a fracture in a formation surrounding the borehole and to propagate into the fractures and further into the formation through the fracture faces;

lowering the pressure in the borehole such that the fluid propagates back from the formation into the fracture;

measuring downhole the values of electric and/or magnetism fields induced by the back propagation of the fluid from the formation into the fracture; and

determining the geometry of the fracture from the measured values.

4. The method according to claim 2, wherein the step of measuring the values of the electric and/or magnetic fields is performed inside a further borehole or boreholes.

5. The method according to claim 3, wherein the step of measuring the values of the electric and/or magnetic fields is performed inside a further borehole or boreholes.

6. A method according to claim 1, further comprising the step of:

providing a model from which expected values of the electric and/or magnetic field at the positions and/or times of the measured values can be calculated for adjustable fracture geometries and injection pressures;

wherein the geometry of the fracture is determined by adjusting the model to minimize the differences between the expected and measured values.

7. A method according to claim 2, further comprising the step of:

providing a model from which expected values of the electric and/or magnetic field at the positions and/or times of the measured values can be calculated for adjustable fracture geometries and injection pressures;

wherein the geometry of the fracture is determined by adjusting the model to minimize the differences between the expected and measured values.

8. A method according to claim 3, further comprising the step of:

providing a model from which expected values of the electric and/or magnetic field at the positions and/or times of the measured values can be calculated for adjustable fracture geometries and injection pressures;

wherein the geometry of the fracture is determined by adjusting the model to minimize the differences between the expected and measured values.

9. A computer system which is operatively configured to determine the geometry of a hydraulic fracture in a subterranean rock formation from measured values of electric and/or magnetic fields induced by the forward or back propagation of a fracturing fluid between the fracture and the rock formation.

10. An apparatus for evaluating a shape of a hydraulic fracture in a rock formation, the apparatus comprising:

a rig for injecting a fracturing fluid into a borehole at a pressure allowing the injected fluid to create a fracture and propagate into the created fracture around the borehole;

at least one downhole tool for measuring electric and/or magnetic fields induced by the propagation of said fluid into the fracture through the fracture faces and by the propagation of this fluid back into the formation from the fracture; and

a computer system according to claim 9, for determining the geometry of the fracture from the measured values of the electric and/or magnetic fields.

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