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Niskakangas(10) **Pub. No.: US 2014/0014589 A1**(43) **Pub. Date: Jan. 16, 2014**(54) **METHOD FOR CLEANING DRILLING FLUID
IN ROCK SAMPLING DRILLING AND A
CLEANING UNIT**(52) **U.S. Cl.**
CPC **E21B 21/068** (2013.01)
USPC **210/712; 210/702; 210/201; 210/202;**
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(FI)**(57) **ABSTRACT**(21) Appl. No.: **14/008,173**(22) PCT Filed: **Mar. 30, 2012**(86) PCT No.: **PCT/FI2012/000019**

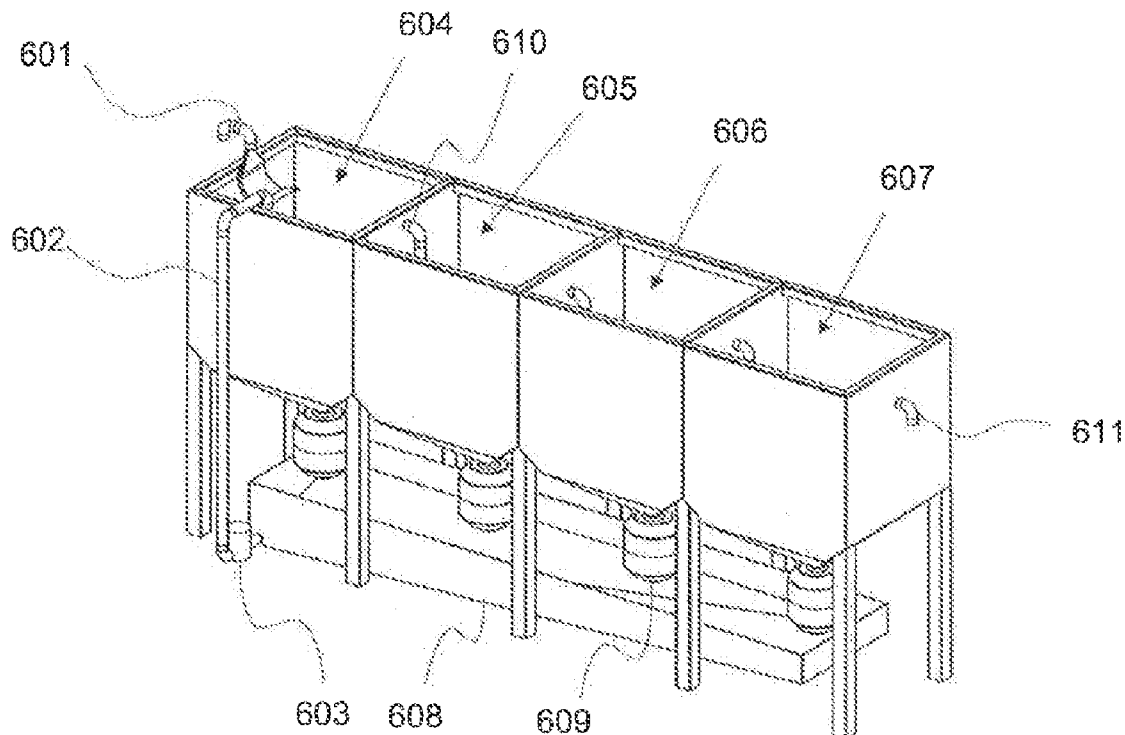
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To recover drilling fluid used in sample drilling at a drilling machine, when the drilling fluid exits the drill hole, and to transport it to a separate cleaning unit wherein solid matter is separated from the drilling fluid. The cleaned drilling fluid is returned to the drilling machine and reused in sample drilling. The cleaning unit has an inlet connection and two or more precipitation basins, where the solid matter accumulates on the bottom of the basin. In the bottom part of at least one precipitation basin there is a valve arrangement for removing drilling fluid sludge containing solid matter from the precipitation basin, which drilling fluid sludge is filtered with a filter arrangement. In the top part of the precipitation basin there is a transfer connection between precipitation basins or an outlet connection for taking cleaned drilling fluid out from the cleaning unit back to the drilling process.



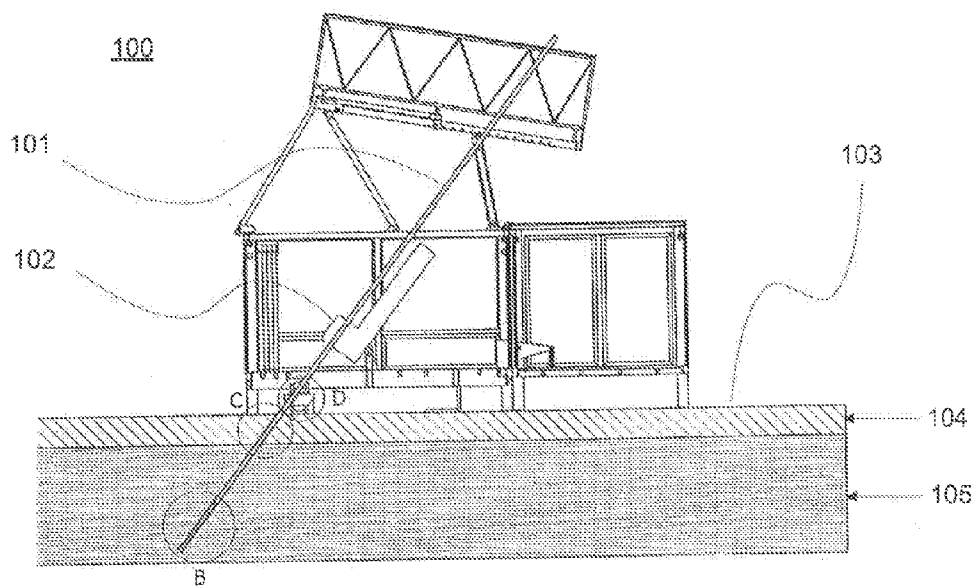


Fig. 1

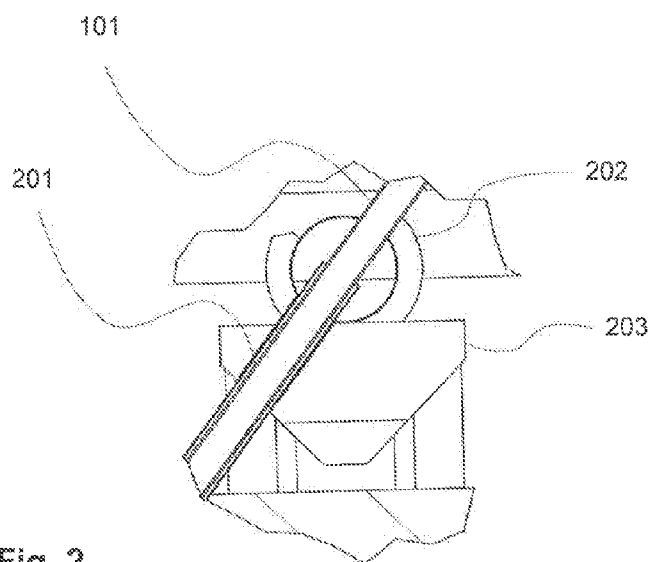


Fig. 2

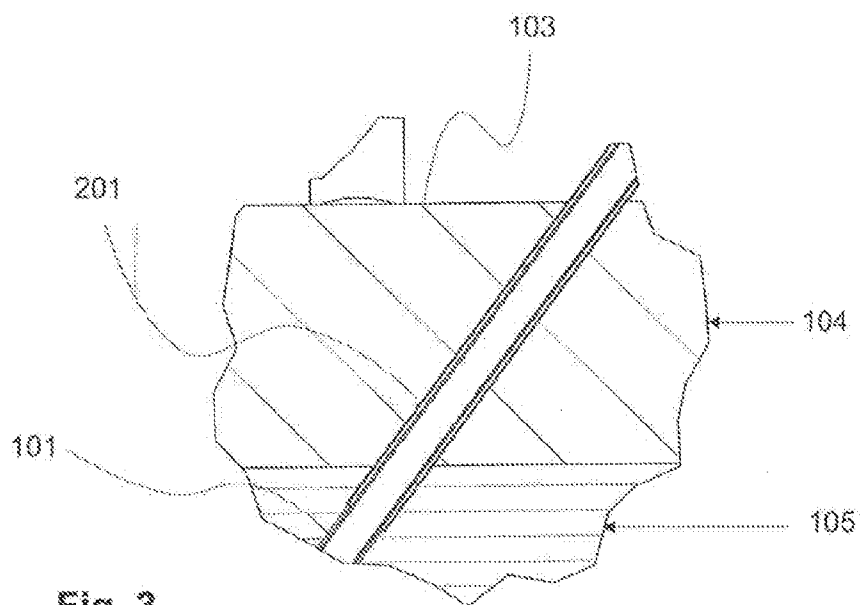


Fig. 3

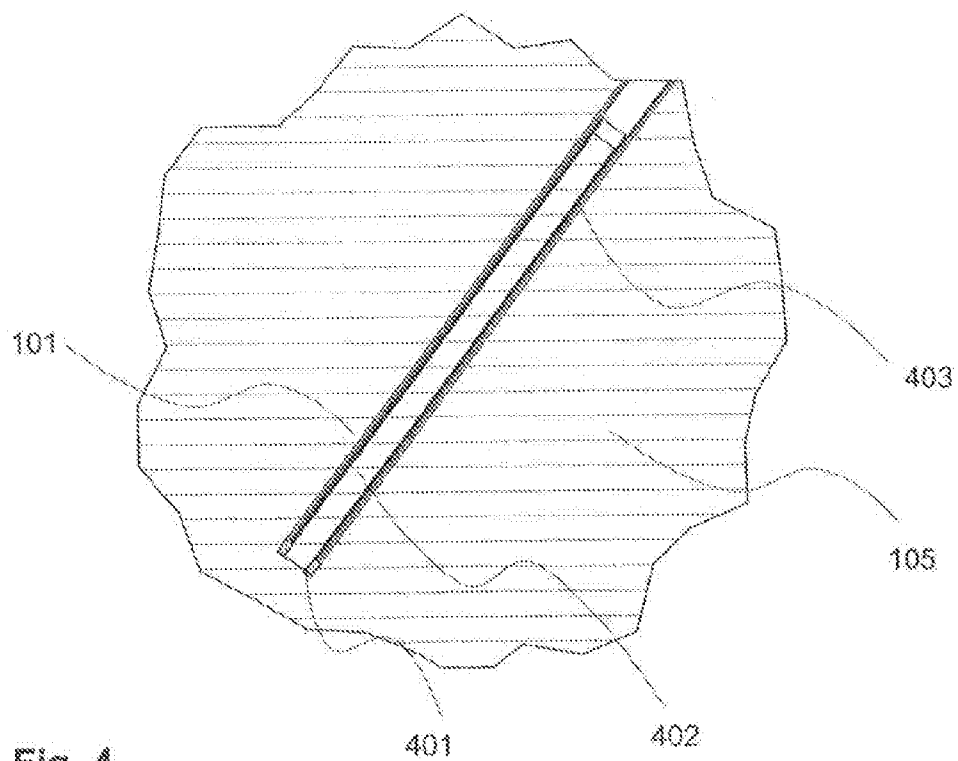


Fig. 4

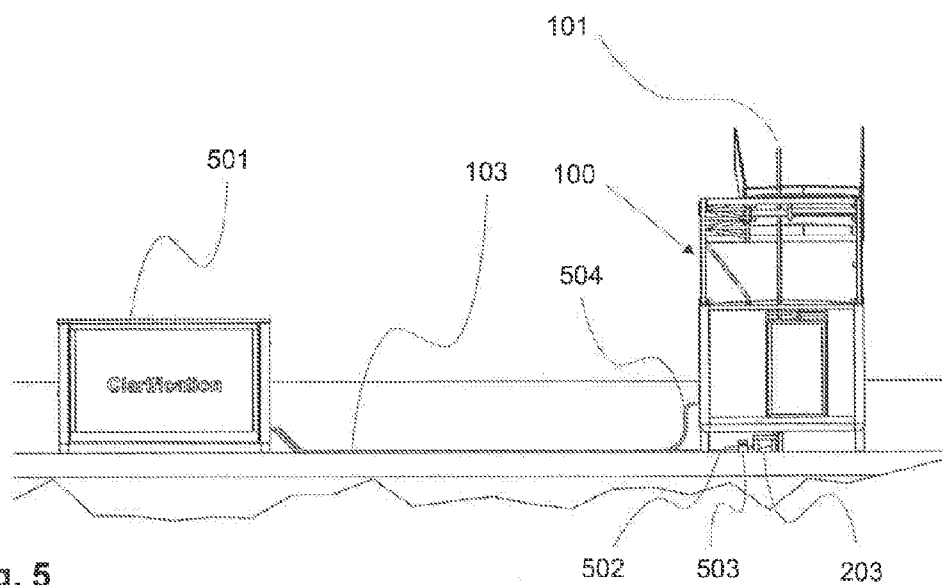


Fig. 5

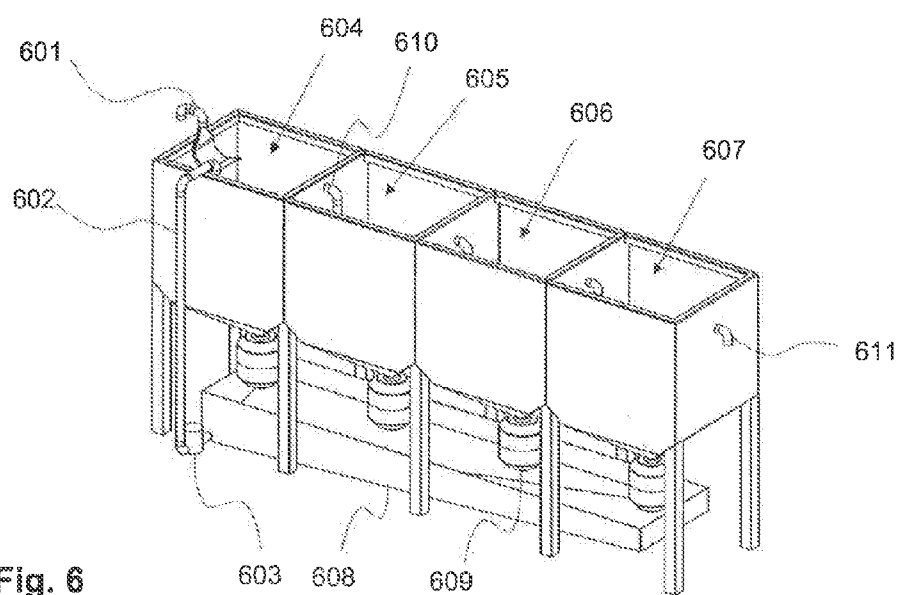


Fig. 6

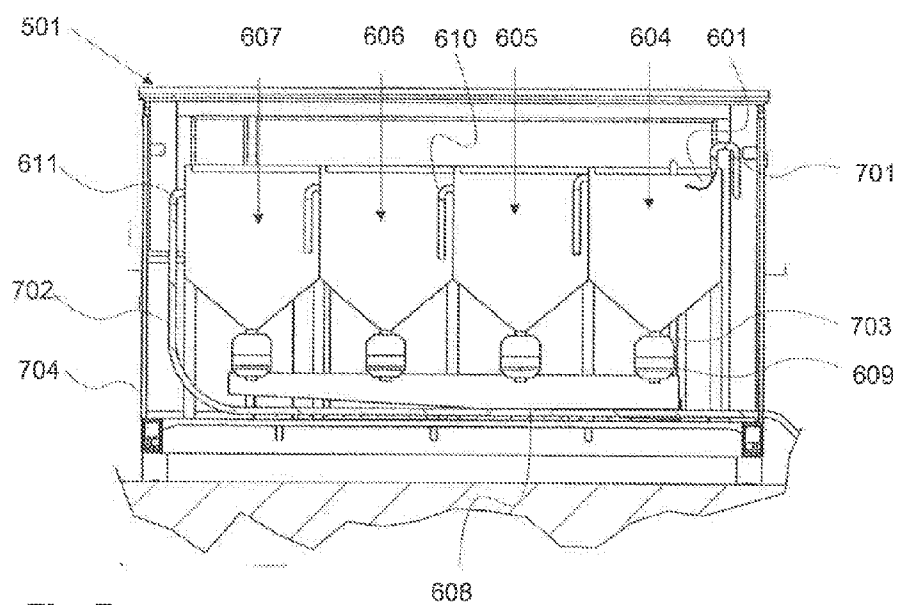


Fig. 7

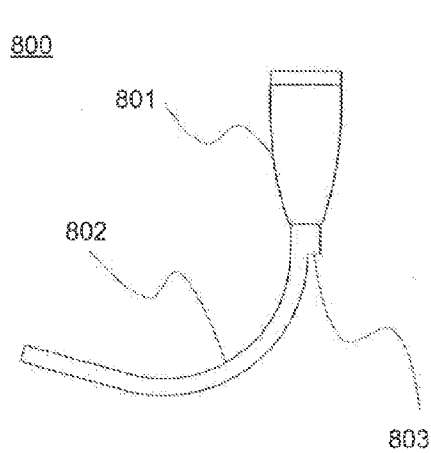


Fig. 8a

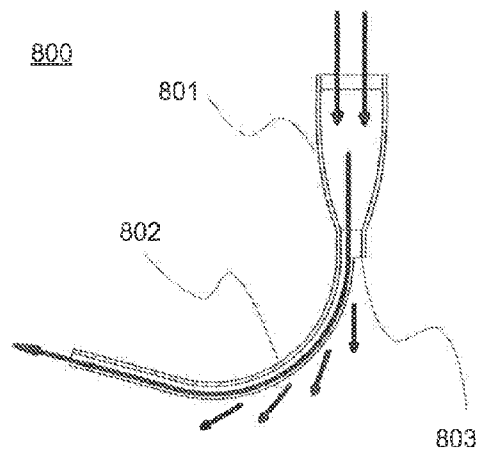


Fig. 8b

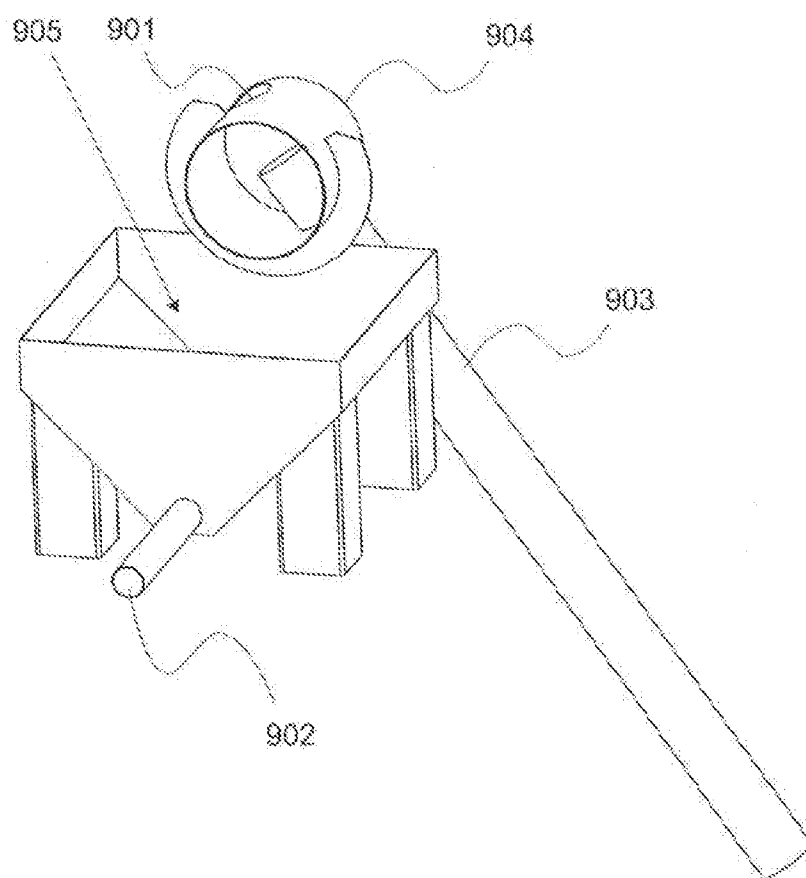


Fig. 9

METHOD FOR CLEANING DRILLING FLUID IN ROCK SAMPLING DRILLING AND A CLEANING UNIT

[0001] The invention relates to a method for cleaning drilling fluid in rock sampling drilling, where a drilling machine is used, which has a hollow drilling pipe, a blade unit in the drilling end of the drilling pipe, a protective pipe, which surrounds the part of the drilling pipe which is close to the ground surface, so that there is empty space between the drilling pipe and the protective pipe, and in the method drilling fluid is fed into the drilling pipe, which drilling fluid lubricates the drilling event, and the drilling fluid flows between the drilling pipe and the wall of the drill hole toward the opening of the drill hole, simultaneously transporting solid matter formed in the drilling. The invention additionally relates to a cleaning unit for the drilling fluid in sampling drilling.

[0002] In ground and rock sampling drilling the aim is to obtain a sample bar from the ground or bedrock over the length of the entire drilling depth or a part of it, which sample bar is generally rock material from the bedrock or in some cases also soil from the ground. The product of the sampling drilling is thus a sample bar raised from the drill hole, which is arranged in sample boxes for example for examination by a geologist. The hole generated in the drilling itself is a by-product, even if it may also in some cases be utilised.

[0003] Sampling drilling differs from other ground drilling fields, such as oil drilling, charging drilling for blasting in the building trade, drilled well or heat well drilling, drilling of charging and guide holes in an ore body in mining, drilling gas exhaust holes in coal mines or holes made in rescue operations. In all these the aim is to drill a hole in the ground or bedrock, which is utilised in different ways in each field. The product of the operation is thus a hole achieved in the ground or bedrock, and the rock material obtained from the drill hole is a by-product or rather waste, which is not utilised in any way. In these drillings all the soil or rock material from the drill hole is crushed and ground with the drilling blade into a quite fine material, which is removed as soil or rock mud with the aid of the drilling fluid flow. In sampling drilling on the other hand, soil and rock material is ground away from the ground and bedrock with a pipe-like blade only from a quite small, circular area. Thus a sample bar containing soil or rock material situated at each drilling depth remains inside the blade and drilling pipe, which sample bar is lifted in parts of a suitable length up from the drill hole and sorted for subsequent examinations.

[0004] In sampling drilling a cylindrical hollow diamond blade placed in the end of a drilling pipe is rotated and pressed with a suitable force against the rock. The power needed for rotating and pressing the blade and drilling pipes is provided with a drilling machine, which contains both a rotating unit and a power means providing supply power. Inside the drilling pipe above the blade unit there is a separate core pipe, which adheres to the rock sample and with the aid of which the rock sample can be lifted up from the hole by means of a device called a retriever and a winch. The sample bar is lifted with the above-described special technology of the sample drilling field, which utilises a core pipe, a retriever and a winch. Deep-reaching rock drilling is not possible to perform without using drilling fluid. Water obtained from nature close to the drilling site is usually used as drilling fluid, or it is

brought to the site in a tank or a corresponding container. In some cases some other fluid than water can be used as the drilling fluid.

[0005] Without drilling fluid the tip of the diamond blade overheats and wears quickly. On the other hand when lubricated and cooled by drilling fluid, the diamond blade lasts very long when used correctly. The drilling fluid also lubricates the rotation of the long drilling pipe inside the rock and removes rock material abraded from the rock, i.e. rock mud, away from the blade and finally out of the drill hole. Quite a little rock mud is formed in the case of sample drilling, because the amount of rock material abraded off the rock is much smaller than in other fields using ground drilling. Most of the rock material in the drill hole remains in the rock material bar formed as a product. Chemicals can, if necessary, be added to the drilling water, which further facilitate the drilling event and prolong the lifetime of the blade, which is prior art as such.

[0006] The drilling fluid lubricating the drilling event is with current technology normally taken from a lake, a ditch or some other natural water source located near the drilling site. If necessary, water collecting in a previously drilled hole may also be utilised. The drilling fluid is fed with a suitable pressure inside the drilling pipe and down along the pipe, all the way to the blade rotating inside the rock. By the drilling blade the drilling fluid lubricates the drilling event, cools the blade and removes rock material generated in the drilling, i.e. drilling mud. Thereafter the drilling fluid and the rock mud it contains flows back upwards outside the wall of the drilling pipe. The fluid and the drilling mud it contains flow upwards between the drilling pipe and the wall of the hole drilled in the rock, pushed by fluid supply pressure prevailing behind it. At the same time the fluid also lubricates the rotation of the drilling pipe in the hole formed in the rock. If the rock is very fractured or porous, some drilling fluid is absorbed into cracks and pores in the rock. This is illustrated in FIG. 4.

[0007] When the drilling fluid gets through the drilling hole drilled in the rock and arrives at the layer of soil between the rock and the ground surface, it travels inside the protective pipe plunged into the soil layer, the so-called soil pipe, upwards to the ground surface. With the aid of the protective pipe the excessive absorption of fluid into the soil material between the ground surface and the rock is avoided. The protective pipe extends somewhat above the ground surface, and its end is situated underneath or inside the drilling machine. This is shown in FIG. 3.

[0008] With current technology the drilling fluid rising from the protective pipe and the possible chemicals it includes and the solid matter, which is rock, soil, metal particles detached from the drilling equipment and other fine solid matter, flow from the opening of the protective pipe underneath the drilling machine and further into the surrounding terrain.

[0009] When rising from the ground the drilling fluid is even in winter clearly warm. The drilling fluid rising from the protective pipe and flowing from underneath the machine to the terrain may in places cause a muddy area which causes soiling of machines, clothes and equipment and which encumbers movement of the crew, and additionally in winter the freezing of the drilling fluid causes a risk of slipping, which are work safety risks. In winter time drilling may be done on the ice of a lake or on a frozen swamp, whereby the ice or frozen surface of the swamp supports the drilling machine. The flow of drilling fluid into the area surrounding

the machine melts the ice or frozen swamp supporting the machine and may cause the machine to sink, which is also a great work safety risk.

[0010] Because the initial drilling fluid is usually taken from a natural water source, it must in sub-zero weather be heated immediately after taking it from the water source, for which a lot of energy is used. If the drilling fluid is not heated, there is at least in very low temperatures and with long water lines a risk of the drilling fluid lines freezing. When a drilling fluid line freezes the drilling operation is immediately interrupted.

[0011] In some cases chemicals must be added to the drilling fluid, which chemicals assist the drilling event. After use the fluid equipped with chemicals flows back into the environment, whereby in addition to having to continuously use quite a lot of additional substances, chemicals added to the fluid also end up in the environment. Even though these chemicals are with current knowledge not regarded as dangerous for the environment, the applicant company has due to a high environmental awareness paid attention to the matter.

[0012] Patent publication US2008/121589 discloses a fluid cleaning apparatus for cleaning drilling fluid so that the fluid could be used again in drilling. This has several successive precipitation basins, between which there are weir walls, which get lower in successive precipitation basins. These weir walls are arranged so that turbulences in the basins are minimised. Such an arrangement, however, makes the removal of fine material from the drilling fluid difficult and in sampling drilling the solid matter in the drilling fluid is mostly fine.

[0013] Patent publication EP 0047347 discloses a closed circulation system for drilling fluid. The drilling operation described in said reference publication is however related to drilling for coal deposits done in coal mines, which drilling only occurs underground and substantially in the horizontal direction. The aim is to drill a hole, which is a few hundred meters long, into a coal deposit, the purpose of which hole is to remove methane gas in a controlled manner from a future mining area. Thus the coal mining later done in the vicinity of the hole would be safer. The technology described here contains a complicated processing apparatus for drilling fluid, which apparatus substantially makes possible the separation of explosive methane gas from fluid and its safe removal. The described apparatus is based on a very complicated technology, where successive sedimentation basins arranged in closed and gastight spaces, optimal boundaries for gas and fluid, which in different basins are at different levels, a screw conveyor used for removing rock material and centrifugal separation used for removing finer rock material and different pumps, systems used for separating fluid, gas and rock material are utilised.

[0014] Patent publication WO 99/15758 discusses the use of a closed drilling fluid circulation system. Here the drilling occurs only in sea areas, for example in connection with oil drilling. The described technology includes a very complicated cleaning system placed at the bottom of the sea, which system only performs removal of coarse rock material. The aim thereof is that the wear of pumps and other technology can be reduced and the reliability of the technology is improved in Offshore conditions.

[0015] Patent publication U.S. Pat. No. 5,928,519 describes the use of a closed drilling fluid circulation system in connection with under-balanced drilling (UBD) in oil and gas drilling. UBD drilling differs from normal oil drilling in

that no overpressure prevails in the drilling fluid in the drill hole and pipe system, but an underpressure is provided in the drilling pipe system with the aid of suction occurring from the drilling fluid outlet side. This in some cases provides definite advantages, such as the fact that the risk of deterioration of the oil deposit is reduced and the risk of the drilling pipe getting stuck in the hole is reduced. Two different closed pressure containers are needed for circulating the drilling fluid, which both contain complicated technology. One container has a higher pressure and the other a lower pressure.

[0016] Patent publication U.S. Pat. No. 5,454,957 describes the use of a closed drilling fluid circulation system in connection with oil drilling, where diesel, mud/drilling mud and fine particles are separated from the drilling fluid. An arrangement for closed circulation is here presented, where very complicated technology is used, including agitators, activated sludge tanks, soil and rock mud washers, mud dryers, intermediate storing tanks for sludge, centrifuge/sling separators, fluid traps, fluid processing devices, diesel separators and tanks, pumps and conveyors. The methods described for recycling the drilling fluid require very complicated apparatuses, the moving of which from one place to another is practically impossible.

[0017] Generally in sampling drilling the amount of used drilling fluid and the amount of fine solid matter formed in the drilling is significantly smaller than with other rock drilling methods. Thus a reason for recycling the drilling fluid has traditionally not been seen. Thus the ways of cleaning drilling fluid for recycling in other drilling methods are also quite difficult to apply to sampling drillings.

[0018] An object of the invention is a solution by which the drawbacks and disadvantages relating to the prior art can be considerably reduced.

[0019] The objects of the invention are attained with a method and a cleaning unit, which are characterised in what is presented in the independent claims. Some advantageous embodiments of the invention are presented in the dependent claims.

[0020] The main idea of the invention is to recover the drilling fluid used in sample drilling at a drilling machine, when the drilling fluid exits the drill hole, and to transport it to a separate cleaning unit. The cleaning unit has two or more precipitation basins, where solid matter is separated from the drilling fluid. The cleaned drilling fluid is returned to the drilling machine and reused in sample drilling.

[0021] The method according to the invention for cleaning drilling fluid in rock sampling drilling comprises using a drilling machine, which has a hollow drilling pipe, a cylindrical blade unit in the drilling end of the drilling pipe, a protective pipe, which surrounds the part of the drilling pipe which is close to the ground surface, so that there is empty space between the drilling pipe and the protective pipe, and in the method drilling fluid is fed into the drilling pipe, which drilling fluid lubricates the drilling event, and the drilling fluid flows between the drilling pipe and the wall of the drill hole toward the opening of the drill hole, simultaneously transporting powder-like solid matter formed in the drilling. The method further has steps, where the drilling fluid coming from between the protective pipe and the drilling pipe in the drilling machine and containing solid matter is recovered with an arrangement in the drilling machine, the recovered drilling fluid is guided to a cleaning unit, which cleaning unit has at least two precipitation basins, where solid matter is separated from the drilling fluid and the drilling fluid cleaned

in the cleaning unit is guided to the drilling machine and fed into the drilling pipe. Of the precipitation basins at least two are in series, i.e. the fluid to be cleaned passes in order from one basin to the next. Uncleaned drilling fluid is fed into the first precipitation basin and cleaned drilling fluid is removed from the last precipitation basin. Between the precipitation basins there is a transfer connection, which has an intake end and a discharge end. The intake end takes fluid from the precipitation basin and the discharge end discharges the fluid into the next precipitation basin. The discharge ends of the transfer connections are closer to the bottom of the basins than the intake ends.

[0022] In one embodiment of the method according to the invention drilling fluid sludge containing solid matter accumulating on the bottom of the precipitation basin is removed from the basin. The drilling fluid sludge contains solid matter to a significantly higher degree than the uncleaned drilling fluid. In a second embodiment of the method according to the invention the drilling fluid sludge accumulating on the bottom of the precipitation basin and containing solid matter is filtered and returned to some precipitation basin.

[0023] In a third embodiment of the method according to the invention the drilling fluid is in the cleaning unit fed into the first precipitation basin through a nozzle, which nozzle has a throat part and a curved flange part, and the curved flange part is arranged so that the fluid flow substantially follows the flange part and solid matters contained in the fluid detach from the flow.

[0024] In a fourth embodiment of the method according to the invention an ion charged polymer mixture, ferrous sulphate, ferric sulphate or some other chemical added to the drilling fluid, which assists the separation of solid matter from fluid, is used in the cleaning of the drilling fluid for boosting the process.

[0025] In a fifth embodiment of the method according to the invention new drilling fluid is, when necessary, added to the drilling fluid circulation.

[0026] In a sixth embodiment of the method according to the invention substances or chemicals which assist the drilling process are added to the drilling fluid before the drilling fluid is returned to the drilling pipe.

[0027] In one embodiment of the method according to the invention the cleaning unit is placed in one or more containers or other movable structures. The walls of the structure are thermally insulated, and a heating device may be installed therein.

[0028] The cleaning unit for drilling fluid in sampling drilling according to the invention has a connection for feeding uncleaned drilling fluid into the cleaning unit, at least two precipitation basins, where solid matter contained in the drilling fluid is arranged to accumulate on the bottom of the basin, where it forms drilling fluid sludge, and in the bottom part of at least one precipitation basin there is a valve arrangement for removing said drilling fluid sludge containing solid matter from the precipitation basin, and between the precipitation basins there is a transfer connection for moving the drilling fluid between precipitation basins and in the last precipitation basin of the series there is an outlet connection for removing the cleaned drilling fluid from the cleaning unit. The transfer connections have an intake end and a discharge end and the discharge ends of the transfer connections are closer to the bottom of the precipitation basins than the intake ends. The cleaning unit is placed in one or more container or corresponding structure meant to be moved.

[0029] In one embodiment of the cleaning unit according to the invention the drilling fluid sludge let through the valve arrangement and containing solid matter is arranged to travel through a filter arrangement for separating the solid matter.

[0030] In a second embodiment of the cleaning unit according to the invention the filter arrangement can be detached for replacement or cleaning or it can be cleaned in its place. In a third embodiment of the cleaning unit according to the invention there is a point in the bottom of the precipitation basin which is lower than the rest of the bottom, wherein the drilling fluid sludge is arranged to accumulate. The valve arrangement is placed in this point. In a fourth embodiment of the cleaning unit according to the invention the drilling fluid separated from the drilling fluid sludge with the filter arrangement is arranged to be transported back to the precipitation basin.

[0031] In a fifth embodiment of the cleaning unit according to the invention there is a lower basin beneath the precipitation basin or precipitation basins, in which lower basin the drilling fluid separated from the drilling fluid sludge with the filter arrangement or filter arrangements is arranged to be collected and from which lower basin there is a transfer arrangement for moving the drilling fluid to the precipitation basin.

[0032] In a sixth embodiment of the cleaning unit according to the invention the uncleaned drilling fluid fed into the first precipitation basin is arranged to be fed through a nozzle (611), which nozzle has a throat part and a curved flange part, and the curved flange part is arranged so that the fluid flow substantially follows the flange part and the solid matters contained in the fluid detach from the flow.

[0033] In a seventh embodiment of the cleaning unit according to the invention the discharge ends of the transfer connections between the precipitation basins are closer to the bottom of the basin than the intake ends and the discharge ends are formed to guide the drilling fluid substantially toward the bottom of the precipitation basin.

[0034] In an eight embodiment of the cleaning unit according to the invention an ion charged polymer mixture, ferrous sulphate, ferric sulphate or some other chemical, which assists the separation of solid matter from fluid, is arranged to be added to the drilling fluid. In a ninth embodiment of the cleaning unit according to the invention it has an arrangement for feeding substances, which assist the drilling event, into the drilling fluid before the drilling fluid is returned to the drilling process.

[0035] An advantage of the invention is that with its aid, work safety risks can be reduced in sample drilling operation. The risk of slipping is reduced, because only very little water, if any at all, flows beneath the drilling machine. The drilling water causes a risk of slipping, except in the winter when freezing, also in the summer, especially if slippery drilling assisting chemicals are used in the fluid.

[0036] It also helps the drilling machine to move in the environment. Without recycling of the drilling fluid a lot of water flows into the terrain surrounding the drilling machine, and the roads surrounding the machine unavoidably become muddy before long. This causes work safety risks when movement becomes more difficult, especially when the crew must carry equipment needed in the drilling, such as drilling pipes and rock samples, when moving around the machine. When recycling drilling fluid these problems are reduced,

because the area around the machine remains dry. The soiling of the crew's clothes and the inner parts of the machine is thus also avoided.

[0037] A further advantage of the invention is that energy is saved with its aid. With traditional technology the drilling water must in wintertime continuously be heated, in order to avoid freezing of the fluid lines. When using initial fluid taken from a ditch or lake with traditional technology, a lot of energy has to be used for heating the fluid. Correspondingly very warm drilling water returning from under the ground is in the traditional method poured into the ground after use, and the thermal energy it contains is lost. In winter the heat of the drilling fluid rising from the ground can when recycling be utilised, whereby a significant amount of energy is saved.

[0038] The invention further intensifies sampling drilling, because it reduces the risk of freezing of the drilling fluid lines in the winter. With the traditional technology the drilling operation must immediately be interrupted when the drilling fluid lines freeze or when the water supply otherwise is interrupted, until water is again obtained to the process. When using the invention, even if the line of the initial replacement water should freeze, the crew would, due to the large amount of fluid in circulation, have plenty of time to repair the lines without having to interrupt the drilling operation. If the drilling operation is for some reason interrupted, the initial drilling fluid must with the traditional technology still be allowed to continuously circulate in vain in order to prevent freezing and the fluid must be allowed to flow to waste as unused. In some cases even all intermediate fluid storages must be emptied in vain due to the risk of freezing. Because in winter the drilling fluid rising from the ground is very warm, this heat can in the case according to the invention be utilised, whereby interruptions in the drilling due to other reasons can even be quite long, without there being a risk of the fluid freezing.

[0039] An advantage of the invention is also that it saves water or other used drilling fluid. In some places finding drilling water can be difficult or the water must be led to the drilling site even from far away. According to the invention the same drilling fluid always circulates in the drilling operation, and it needs to be added only for example for compensating evaporation and fluid absorbed into cracks in the rock or into the ground from the boundary of the protective pipe.

[0040] An advantage of the invention is still that the used chemicals do not flow into the environment in an uncontrolled manner. Chemicals, which facilitate the drilling operation, must in certain situations be added to the drilling fluid. According to the traditional technology these chemicals continuously flow into the environment. Even though these chemicals are according to current knowledge not harmful for the environment, it is better that substances are not let into the environment, which do not belong there. When using the invention significantly less of these chemicals is also needed in comparison to the traditional technology. When the same drilling fluid is recycled, chemicals do not need to be used in the same amount as normally. When using initial water a lot of chemicals which assist drilling must be added, when on the other hand the water in circulation according to the invention, which is already processed with chemicals, already contains the necessary chemicals.

[0041] An advantage of the invention is also that with its aid, a large part of the rock mud from the drilling hole is recovered. As of now, this mass has no practical use, but when it is in accordance with the invention begun to collect, it may be utilised over time for example as a work site-specific rock

mud sample. Additionally in some examination sites the drilling permit requires cleaning up after oneself and the invention significantly facilitates this.

[0042] In the following, the invention will be described in detail. In the description, reference is made to the enclosed drawings, in which

[0043] FIG. 1 shows as an example a drilling machine,

[0044] FIG. 2 shows as an example a cross section of an arrangement according to the invention for collecting drilling fluid,

[0045] FIG. 3 shows as an example a drilling pipe and a protective pipe,

[0046] FIG. 4 shows as an example a drilling pipe,

[0047] FIG. 5 shows as an example an arrangement according to the invention,

[0048] FIG. 6 shows as an example the inner structure of a cleaning unit according to the invention,

[0049] FIG. 7 shows as an example a longitudinal cross section of a cleaning unit according to the invention,

[0050] FIG. 8a shows as an example a nozzle used in one embodiment of the invention,

[0051] FIG. 8b shows the fluid and solid matter flows caused by the nozzle of FIG. 8a and

[0052] FIG. 9 shows as an example an arrangement according to the invention for collecting drilling fluid.

[0053] FIG. 1 shows as an example a drilling machine **100** for sample drilling. The drilling machine has a drilling pipe **101** and a drilling unit **102**, with which the movement needed for the drilling is produced. The drilling machine has a frame, which supports the structures of the drilling machine. The frame has arrangements, with which the angle of the drilling pipe and simultaneously the angle of the drill hole are adjusted. In the case according to the figure the drilling machine is on the ground surface **103**, but it can be placed for example on a raft or in a mine. In sample drilling the aim is usually to obtain rock samples from the bedrock. The rock **105** is usually covered by a layer of soil **104**. The drilling machine has an arrangement, with which drilling fluid is fed into the drilling pipe. Points B, C and D are marked in the figure, which points are presented in more detail in FIGS. 4, 3 and 2.

[0054] FIG. 2 shows an arrangement according to the invention for collecting drilling fluid as a cross section. The arrangement has a drilling pipe **101**, a protective pipe **201**, a collecting collar **202** and a collecting basin **203**. The drilling pipe is hollow, and the drilling unit rotates it. The protective pipe is around the drilling pipe so that it extends substantially through the soil layer and its end toward the drilling machine is above the ground surface. The drilling fluid returning from the drilling process, which rises from a gap between the protective pipe and the drilling pipe, is collected with a collecting collar situated around the end of the protective pipe and guided to the collecting basin. The collecting basin is attached either to the machine or with a joint to the protective pipe. The collecting basin is shaped and placed so that the position of the drilling can be moved at least in the commonly used drilling angles, i.e. in a 30-90° angle in relation to the horizontal plane, and that the drilling fluid coming from the protective pipe ends up in the collecting basin regardless of the position of the drill. The movement seam between the protective pipe and the collecting basin can, if necessary, be tightened for example with a tightener manufactured from tarpaulin or a flexible rubber, which allows the necessary movement area of the drill and guides the drilling fluid com-

ing from the protective pipe at least almost completely into the collecting basin. From the collecting basin the drilling fluid and the solid matter it contains, such as soil and rock mud, and possible drilling additives, are guided into a cleaning unit, which can be moved in the terrain.

[0055] FIG. 9 shows a second example of an arrangement according to the invention for collecting the drilling fluid in a drilling machine. The arrangement has a protective pipe **903**, a collecting collar **904** and a collecting basin **905**. The collecting collar has a hole **901** for the drilling pipe. The water coming from the protective pipe is collected with the collecting collar and guided to the collecting basin. The collecting basin has a pipe **902**, with which the uncleaned drilling fluid is removed from the collecting basin and guided with some arrangement into the cleaning unit.

[0056] FIG. 3 illustrates the placement of the protective pipe **201** in the sample drilling. The drilling pipe **101** has been used to drill a sampling hole from the ground surface **103** through the soil layer **104** into the rock **105**. In the case according to the figure the protective pipe extends through the soil layer some way into the rock. The drilling fluid rising between the wall of the drill hole and the drilling pipe mostly goes between the protective pipe and the drilling pipe and continues to rise.

[0057] FIG. 4 shows the drilling end of the drilling pipe **101** inside the rock **105**. In the end of the drilling pipe there is a cylindrical blade part **401**, which when it rotates drills a rock sample bar **402** from the rock. Inside the drilling pipe there is a core pipe **403**, inside which the rock sample bar goes. With the core pipe the rock sample bar can be lifted to the ground surface and stored. The drilling fluid gets to the blade part between the core pipe and the inner wall of the drilling pipe. As a difference to other drilling fields, only a little rock mud accumulates in the drilling fluid in sampling drilling, because the blade used in the drilling grinds away only a small part of the area of the drill hole. The largest part of the rock material remains in the rock sample bar generated as a product of the drilling operation, which rock sample bar is traditionally according to prior art lifted with a core pipe up from the drill hole.

[0058] FIG. 5 shows an arrangement according to the invention for cleaning and reusing drilling fluid in sample drilling, which arrangement has a drilling machine **100** and a cleaning unit **501** for cleaning the drilling fluid. The drilling machine is used to drill a drill hole for taking samples from the bedrock. The drilling machine has a drilling pipe **101** and a collecting basin **203** which collects drilling fluid coming from the drill hole during drilling. From the collecting basin the drilling fluid is led with a pipe **502** for uncleaned drilling water to the cleaning unit. If necessary, pressure is provided in the pipe with a pump **503**. Because the drilling fluid does not contain a very large amount of solid matter, it is very fluid, and a pump is not in all cases necessary needed for transferring the drilling fluid from the collecting basin to the cleaning unit. If the drilling machine is higher in the terrain than the cleaning unit, the drilling fluid can be allowed to flow along a sufficiently large pipe with the aid of gravity. If necessary, a suitable pump is still used for ensuring the transfer of the fluid.

[0059] The cleaning unit **501** may be some thereto suitable structure, such as for example a container, a wagon or a vehicle, inside which the apparatus needed for the cleaning is placed. This container, wagon or vehicle or other structure is on the other hand placed in the terrain in the vicinity of the

drilling machine **100**, and when the drilling site is moved it can be moved along with the drilling machine either with the aid of another vehicle or with its own power of movement. The cleaning unit has means, with which its position can be adjusted as desired, even if the ground surface it stands on is uneven. The cleaning unit contains either just an apparatus needed for cleaning fluid or additionally also an apparatus used for blending chemicals needed in the drilling process into the drilling fluid. Because the apparatus needed for blending chemicals is not used in every drilling site, it may be advantageous to place the apparatus for blending chemicals in its own separate movable container, wagon or vehicle. Whether the apparatus for blending chemicals is placed in the same space or in a different space than the apparatus for cleaning drilling fluid, they are arranged so that they can according to need either both be used at the same time or each of them separately. From the cleaning unit the cleaned drilling fluid is brought to the drilling machine with a pipe **504** for cleaned drilling fluid. At the drilling machine the cleaned drilling fluid is fed back into the drilling pipe.

[0060] Even though the drilling fluid circulating in the drilling process stays warm during the drilling operation even in winter due to the ground heat of the drill hole and the friction caused by the rotation of the drilling blade and the pipes, there is during winter a risk that the drilling fluid freezes mostly in situations, where the drilling operation is stopped for a long time. Therefore the cleaning system for drilling fluid is placed in a structure, the walls of which are thermally insulated, if it is used in winter conditions. Sufficient heating is also arranged inside the structure, so that the fluids and devices it contains do not freeze in sub-zero weather if the drilling operation is interrupted.

[0061] FIG. 6 shows the inner structure of a cleaning unit according to the invention. The cleaning apparatus according to the example has four precipitation basins: a first precipitation basin **604**, a second precipitation basin **605**, a third precipitation basin **606** and a fourth precipitation basin **607** and a lower basin **608** beneath these. There are at least two basins. The drilling fluid to be cleaned is guided into the first precipitation basin with a nozzle **601**. Between the precipitation basins there are transfer connections **610**. For removing the cleaned drilling fluid from the cleaning unit there is an outlet connection **611**. In the bottom of each precipitation basin there is a valve arrangement, which can be used to let drilling fluid sludge accumulating at the bottom of the precipitation basins out of the precipitation basin. A filter arrangement **609** for the drilling fluid sludge is attached to the valve arrangement. An evacuation pipe **602** for the lower basin is connected to the lower basin, which evacuation pipe has a pump **603**.

[0062] The precipitation basins of the cleaning apparatus are shaped so that the solid matter contained in the fluid separates from the fluid and sinks to the bottom of the precipitation basin, forming drilling fluid sludge. The uncleaned drilling fluid is brought into the first precipitation basin **604** through a nozzle **601**. This may for example be a Coanda type nozzle, with which the fluid part and solid matter parts of the drilling fluid are set into motion in different directions. The solid matter is directed so that it ends up on the bottom of the first precipitation basin. From the first precipitation basin the drilling fluid moves with a transfer connection **610** to the second precipitation basin **605**. The transfer connection is placed so that the drilling fluid is removed from the top part of the precipitation basin. If necessary, several successive precipitation basins can be used, whereby the fluid is moved to a

new precipitation basin, where the same process occurs again. When several precipitation basins are used in succession, drilling mud and solid matter is mostly accumulated in the first precipitation basin, and thereafter the drilling fluid may still be somewhat turbid. The amount of solid matter in the drilling fluid decreases and the drilling fluid is cleared up as it advances from one precipitation basin to another. Precipitation basins are placed in the cleaning unit in such a number, that the drilling fluid in the last precipitation basin is sufficiently clean, so that it can be used again in drilling. In the example according to the figure the precipitation basins are placed in succession, but their position may also be some other. They may be adjacent to each other, in succession or in several rows.

[0063] If necessary, a small amount of a polymer solution with a suitable ionic electric charge, ferrous sulphate or ferric sulphate, which are commonly used in connection with for example waste water cleaning and sludge drying, may be added to the drilling fluid in some precipitation basin, which substances when mixed with water cause so-called coagulation and/or flocculation, i.e. an electrochemical reaction, where solid matters in the water bind together as larger particles, which assists the separation of solid matter from the water and its flowing to the bottom of the precipitation basin a drilling fluid sludge.

[0064] Underneath the precipitation basins is placed a detachable mechanical filter arrangement **609** based for example on filter cloth, by means of which most of the solid matter contained in the drilling fluid sludge removed from the bottom of the basin is separated therefrom. Most of the drilling fluid sludge flows through the filter arrangement. Solid matter left inside the filter arrangement can be removed by detaching the filter arrangement. The filter arrangement can either be disposable or such that it can be emptied from solid matter, washed and reused. The moist solid matter mass obtained with the aid of the filter arrangement can, if necessary, be stored either in the filter itself or for example in a separate vessel, such as a plastic bottle, if the solid matter should in the future for example obtain a work site-specific purpose related to sampling.

[0065] The drilling fluid separated from the drilling fluid sludge with the filter arrangement **609** is poured into the lower basin **608**, from where it at times is transferred back into some precipitation basin via the evacuation pipe **602** of the lower basin. In the example according to the figure the pipe has a pump **603** and it leads to the first precipitation basin **604**. If the filter arrangement can be cleaned and reused, the filter cloth of the filter arrangement can be washed after the filter arrangement is emptied for example with water contained in either the lower basin or the precipitation basin.

[0066] When the drilling fluid has been sufficiently cleaned in the precipitation basins, chemicals assisting the drilling process are, if necessary, added thereto in a chemical mixing apparatus, which contains at least two successive basins. In the first basin, which may be smaller, a necessary amount of a desired chemical is mixed into the drilling fluid, and in the second basin, which may be larger, there is a sufficient intermediate storage for drilling fluid, so that the drilling operation can take place continuously, without disturbances from the possible cyclic nature of the drilling fluid cleaning or the chemical addition process. The apparatus arranged for adding chemicals is placed either in the same space as the cleaning apparatus or if necessary in its own separate space, which is transported to the drilling site only when needed. In the

example according to FIG. 6 the third precipitation basin **606** may function as a chemical mixing basin and the fourth precipitation basin **607** as an intermediate storage for drilling fluid. When adding chemicals the pH value of the drilling fluid is also measured, because the dosing of drilling assisting chemicals may depend on the pH value and some chemicals do not mix in to the drilling fluid or function in a desired manner, if the pH value is wrong. The measured pH value of the drilling fluid can be changed as desired by adding chemicals which adjust pH value to the drilling fluid.

[0067] The drilling machine suctions the drilling fluid it needs for drilling for example either from the last precipitation basin of the cleaning unit or from the last intermediate storage basin of the chemical mixing apparatus. Thereafter the cleaned and treated drilling fluid is brought to the drill hole and it returns after having been at the drill blade along the drill hole and protective pipe back to the drilling machine, where it again flows to the collecting basin waiting by the opening of the protective basin and starts a new treatment cycle.

[0068] Some of the drilling fluid is lost despite the circulation, for example due to evaporation of the warm water, absorption into the fractured bedrock, loss occurring at the boundary between the protective pipe and the rock or loss occurring in connection with the removal of solid matter from the basin. This is compensated with a traditional method, by taking substituting initial fluid from a natural water source or from a previous drill hole or a tank vehicle or the like. The new drilling fluid can be added to the drilling process at the drilling machine or the cleaning unit has an arrangement, for example a coupling, which is in connection with some precipitation basin, with which the new drilling fluid is added to the circulation of drilling fluid.

[0069] FIG. 7 shows a longitudinal cross section of a cleaning unit **501** according to the invention, which has a cleaning apparatus according to FIG. 6. The cleaning apparatus is placed inside a frame **704**. The frame is sufficiently sturdy for transport and moving and it has necessary hatches, doors, ventilation openings and the like. The walls of the frame are sufficiently thermally insulated in relation to the use environment of the cleaning unit. For example the walls of a cleaning unit intended for winter use are very thermally insulated, but for a cleaning unit adapted for mine use compactness and a small size are more useful. Inside the frame there are also necessary arrangements for the driving force of the cleaning apparatus. These are motors, batteries, wirings and the like. Advantageously all the connections of the cleaning unit, the intake and outlet of drilling fluid, the addition of new drilling fluid, the electric wires and the like, can be detached and protected for when the cleaning unit is moved. The cleaning unit has adjustment means, such as adjustment legs, with which the position of the cleaning unit can be adjusted. With these adjustment means it is striven to hold in the designed position regardless of the tilting of the terrain or the shape of the ground surface. This position is advantageously the horizontal position.

[0070] The drilling fluid to be cleaned is brought to the cleaning unit **501** with an inlet pipe **701**, which is in contact with the nozzle **601**. The nozzle may be a Coanda type nozzle. The inlet pipe has a suitable pressure, so that the fluid flow arrives at the nozzle with the correct speed. This pressure can be adjusted for example with valves.

[0071] The four precipitation basins of the cleaning apparatus: the first precipitation basin **604**, the second precipita-

tion basin **605**, the third precipitation basin **606** and the fourth precipitation basin **607**, are shaped to have a conical bottom or so that some part of the bottom is lower than the rest of the bottom and the shapes of the bottom slant toward this part. The precipitation basins may be open or they may have lids. Between the precipitation basins there is a transfer connection **610** for transferring drilling fluid from one precipitation basin to another. The transfer connection takes the drilling fluid from the top part of the precipitation basin. The intake opening of the transfer connection determines the upper surface of the fluid in the precipitation basin, because the drilling fluid always flows to the next precipitation basin, when the fluid surface rises to the intake opening. The intake openings of the transfer connections can be at different heights, whereby the fluid surfaces are at different heights in different precipitation basins. In the case shown in the figure the transfer connection is a pipe, which guides drilling fluid coming from the previous precipitation basin towards the bottom of the precipitation basin. The discharge end of the pipe is substantially lower than its intake end in the precipitation basin. Because the fluid flow through the transfer connection is quite slow, the solid matter contained in the drilling fluid has time to sink to the bottom of the precipitation basin.

[0072] In the bottom of the precipitation basins, substantially at their lowest point, there is a valve arrangement **703**. This is in connection with the filter arrangement **609** so that the valve arrangement can, when necessary, be opened, and drilling fluid sludge on the bottom of the precipitation basin, which contains a lot of solid matter, can be let through the filter arrangement. The opening of the valve arrangement can be done manually or automatically. Because solid matter is accumulated in different precipitation basins at different rates, for example precipitation matter is accumulated faster in the first precipitation basin **604** than in the fourth precipitation basin **607**, the valve arrangements of the precipitation basins are opened at different times. The filter arrangements can also be different in different precipitation basins. The drilling fluid separated from the drilling fluid sludge with the filter arrangement goes into the lower basin **608**, which may be an open or closed container. From here the drilling fluid is led back to the filtering basin. The fourth, last, precipitation basin **607** has an outlet connection **611**, which is in connection with an evacuation pipe **702** for cleaned drilling fluid, with which the drilling fluid is returned to the drilling machine.

[0073] FIGS. **8a** and **8b** show a nozzle **800**, which uses the Coanda phenomenon. It has an inlet part **801**, a throat part **803** and a curved flange part. In the Coanda phenomenon a flow of fluids and gases occurring near a solid surface has a tendency to follow the shape of the solid surface, even if the direction of the surface changes in relation to the direction of the flow. When the nozzle is shaped in the correct way, the direction of the fluid flow can be changed so quickly that the solid matters contained in the fluid detach from the flow and efficiently separate from the fluid. The inlet part is connected to the pipe bringing uncleaned drilling fluid to the cleaning unit. The throat part is shaped so that the flow rate of the drilling fluid passing through it can be made such that the Coanda phenomenon occurs in the curved flange part, where the drilling fluid starts to follow the surface of the flange part. Thus the flow of drilling fluid undergoes a sudden change in direction based on the Coanda phenomenon, where the solid matter contained in the drilling fluid efficiently detaches from the fluid flow immediately as it arrives in the precipitation basin and where

the flow rate of the fluid thereafter quickly decreases. The location of the nozzle is selected so that the drilling fluid flow turned with the nozzle is close to the level of the fluid surface of the precipitation basin and substantially in the direction thereof. Depending on the case the flow of drilling fluid may also be slightly diagonally upwards or diagonally downwards in relation to the fluid surface. The direction of the solid particles is substantially toward the bottom of the precipitation basin. This is shown in FIG. **8b**, where the fluid flow follows the curved flange and the solid matter particles separate from the fluid flow. The flow occurring on the fluid surface of the precipitation basin is slow immediately after detaching from the nozzle. The fluid transfers to a transfer connection located at the second edge of the precipitation basin, whereby solid matter possibly still remaining in the drilling fluid has time to sink further and separate from the slow flow occurring on the upper surface of the fluid in the precipitation basin.

[0074] Some advantageous embodiments according to the invention have been described above. The invention is not limited to the solutions described above, but the inventive idea can be applied in numerous ways within the scope of the claims.

1. A method for cleaning drilling fluid in rock sampling drilling, where a drilling machine (**100**) is used, which has a hollow drilling pipe (**101**), a cylindrical blade unit (**401**) in the drilling end of the drilling pipe, a protective pipe (**201**; **903**), which surrounds the part of the drilling pipe which is close to the ground surface (**103**), so that there is empty space between the drilling pipe and the protective pipe, and in the method drilling fluid is fed into the drilling pipe, which drilling fluid lubricates the drilling event, and the drilling fluid flows between the drilling pipe and the wall of the drill hole toward the opening of the drill hole, simultaneously transporting solid matter formed in the drilling, characterised in that the method further has steps, where

drilling fluid containing solid matter coming from between the protective pipe and the drilling pipe in the drilling machine is recovered with an arrangement in the drilling machine

the recovered drilling fluid is guided to a cleaning unit (**501**)

the cleaning unit has two or more precipitation basins (**604**, **605**, **606**, **607**) in series, where the solid matter is separated from the drilling fluid, and between the precipitation basins there is a transfer connection, which has an intake end and a discharge end, and the discharge ends of the transfer connections are closer to the bottom of the precipitation basins than the intake ends and

the drilling fluid cleaned in the cleaning unit is guided to the drilling machine and fed into the drilling pipe.

2. The method according to claim 1, characterised in that drilling fluid sludge containing solid matter accumulating at the bottom of the precipitation basin (**604**, **605**, **606**, **607**) is removed from the basin.

3. The method according to claim 2, characterised in that the drilling fluid sludge removed from the bottom of the precipitation basin (**604**, **605**, **606**, **607**) is filtered and returned to some precipitation basin.

4. The method according to claim 1, characterised in that the drilling fluid is in the cleaning unit fed into the first precipitation basin through a nozzle (**611**), which nozzle has a throat part (**803**) and a curved flange part, and the curved

flange part is arranged so that the fluid flow substantially follows the flange part and solid matters contained in the fluid detach from the flow.

5. The method according to claim 1, characterised in that an ion charged polymer mixture, ferrous sulphate, ferric sulphate or some other chemical added to the drilling fluid, which assists the separation of solid matter from fluid, is used in the cleaning of the drilling fluid for boosting the process.

6. The method according to claim 1, characterised in that new drilling fluid is, when necessary, added to the circulation of drilling fluid.

7. The method according to claim 1, characterised in that substances or chemicals, which assist the drilling process, are added to the drilling fluid before the drilling fluid is returned to the drilling pipe.

8. The method according to claim 1, characterised in that the cleaning unit (501) is placed in a container or another movable structure.

9. A cleaning unit (501) for drilling fluid in sampling drilling, characterised in that the cleaning unit is placed in one or several containers or corresponding movable structures and the cleaning unit has

a connection (701) for feeding uncleaned drilling fluid into the cleaning unit

at least two precipitation basins (604, 605, 606, 607), where solid matter contained in the drilling fluid is arranged to accumulate on the bottom of the basin as drilling fluid sludge, and in the bottom part of at least one precipitation basin there is a valve arrangement (703) for removing said drilling fluid sludge containing solid matter from the precipitation basin and

between the precipitation basins there is a transfer connection (610), which has an intake end and a discharge end, for moving the drilling fluid between precipitation basins, and the discharge ends of the transfer connections are closer to the bottom of the precipitation basins than the intake ends, and in the last precipitation basin of the series there is an outlet connection (611) for removing the cleaned drilling fluid from the cleaning unit.

10. The cleaning unit (501) according to claim 9, characterised in that the drilling fluid sludge containing solid matter, which has been let through the valve arrangement (703), is arranged to pass through a filter arrangement (609) in order for the solid matter to be removed.

11. The cleaning unit (501) according to claim 10, characterised in that the filter arrangement (609) is detachable for replacing and cleaning or is can be cleaned in its place.

12. The cleaning unit (501) according to claim 9, characterised in that there is a point in the bottom of the precipitation basin (604, 605, 606, 607), which is lower than the rest of the bottom, and the valve arrangement (703) is placed in this point.

13. The cleaning unit (501) according to claim 9, characterised in that the drilling fluid separated from the drilling fluid sludge with the filter arrangement (609) is arranged to be transported back to the precipitation basin (604, 605, 606, 607).

14. The cleaning unit (501) according to claim 9, characterised in that beneath the precipitation basin or precipitation basins (604, 605, 606, 607) there is a lower basin (608), wherein the drilling fluid filtered from the drilling fluid sludge with the filtering arrangement (609) is arranged to be collected and from which lower basin there is a transfer arrangement for transferring drilling fluid to the precipitation basin.

15. The cleaning unit (501) according to claim 9, characterised in that the uncleaned drilling fluid fed into the first precipitation basin is arranged to be fed through a nozzle (611), which nozzle has a throat part (803) and a curved flange part, and the curved flange part is arranged so that the fluid flow substantially follows the flange part and the solid matters contained in the fluid detach from the flow.

16. The cleaning unit (501) according to claim 9, characterised in that the discharge ends of the transfer connections (610) between the precipitation basins are shaped to guide the drilling fluid substantially toward the bottom of the precipitation basin.

17. The cleaning unit (501) according to claim 9, characterised in that an ion charged polymer mixture, ferrous sulphate, ferric sulphate or some other chemical, which assists the separation of solid matter from fluid, is arranged to be added to the drilling fluid.

18. The cleaning unit (501) according to claim 9, characterised in that it has an arrangement for feeding substances which assist the drilling event into the drilling fluid before the drilling fluid is returned to the drilling process.

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