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(54) **BITLESS DRILLING SYSTEM**

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(57) **ABSTRACT**

Deep drillholes of 2 or more meters diameter down to 14-20 km and more, are with current technology extremely expensive and often not possible.

Such wells are needed to run almost anywhere old nuclear/coal powerstations cheaply by geothermal steam: Water/cool steam down and hot steam up. As by-product energy is $CO_2$-free.

Steel and rock can be cut by heat of any type: conductive, radiative and heat-transmission by contact. This principle is used in the steel industry by (translated from German) "burning-cutting machines". In addition rock can be cut by heat-induced evaporation.

A ring with radii and segments that carry one to hundreds heat-generating elements moves through the rock. This way, with fairly low energy-consumption, coring is done at a high speed at almost (any) diameter. Stafette-type core- and equipment transport ensures the speed of the drilling system.

# BITLESS DRILLING SYSTEM

## PROBLEM

**[0001]** Deep drillholes, particularly future exceptionally deep drillholes (14-20 km and more) are with current technology extremely expensive, extremely time-consuming and sometimes (exceptionally deep drillholes, for example to reach 300° C. in NW-Germany, in the Midwest of the United States or Sweden) not possible at all or not economic.

**[0002]** Reaching 300° C. is economically relevant: If 300° C. can be reached almost anywhere then old nuclear powerstations and most old coal-powerstations can get an extended lifetime because the steam gets provided geothermally: Feeding water in a closed system downward, heating it up in the crust, getting hot steam upward, applying a heat-exchanger as in nuclear powerstations so the turbines get the steam they are used to—just the normal power-technology without building new powerstations. As a by-product energy will be provided safer and of course $CO_2$-free. Furthermore the steam can be circulated as steam through neighborhoods near the powerstation: This way (small local heat exchangers) the steam cools down to water and heats houses of neighborhoods/suburbs/small cities cost effectively. Until now people prospected for suitable sites. Most suitable sites are in tectonically active regions. With this fast drilling technology tectonical questions can be avoided by drilling in tectonically calm regions (Scandinavia, large parts of North America etc.).

**[0003]** One reason for the technological problems that prevented such deep drillholes is that for oil-wells and other deep drillholes people drill as 150 years ago: The drive is at the top, the drillbit at the bottom and the whole drilling is steered from the top.

**[0004]** In addition cutting the rock at the whole diameter and pumping the cuttings through a circulation upward is costly (energy, wearing the drillbit). If, at a given diameter, such as two meters, only a fraction of rock needs to be cut, then, due to the lower amount of energy that is needed a lower amount of costs results. In addition drilling is of course faster. Depths in which 300° C. are observed in NW Germany, the Midwest of the US and Scandinavia can thus be reached much faster, for example in about one-three weeks. Thus at a site of a large powerstation 20-30 wells at 2 meter diameter can be brought down economically so the necessary amounts of steam result. This implies that existing investments (old nuclear powerstations, old coal powerstations) can be kept in use.

**[0005]** Important side aspect: If factually 300° C. can be reached almost anywhere the known high-temperature areas and their geological problems can be avoided.

**[0006]** The location of the existing powerstations will be the locations of the drillsites.

**[0007]** The solution is achieved by integrating existing, known and proven technologies, from outside geology as well, such, that a completely new system results. This compares to the invention of anti-sliding systems for car-brakes: The components (wheels, hydraulic pipes, hydraulic brakes, sensors to measure the rotation of the wheels, valves to reduce pressure in the hydraulic pipes, a small computer, cables) existed well before.

**[0008]** By integrating known technology in an innovative way something totally new, a powerful and safe braking-system for cars, resulted. The bitless drilling-system integrates many known individual components (cables, heat-generators for melting rock, elevators to transport core-segments, cables, LAN/WLAN, cameras and manipulators, possibly for very shall depths where it might make sense, pumps, jets, concrete) such that drillings will be done highly innovatively without drillbit and without drillstring. This way 14-20 and more kilometers depth can be reached quite fast. This implies: The drilling system may be run almost or completely without movable parts and, without water/mud. This way very hot areas can be reached easily as heat-resisting materials exist, for example in the steel-making industry.

**[0009]** As right now the "whole world" drills for deep drillholes with drillbit and as 14-20 km deep wells cannot be reached economically the high level of innovation is thus proven.

**[0010]** The fact that people aim at the new construction of powerstations (nuclear and coal) shows that the solution of this patent is highly innovative.

## SOLUTION

**[0011]** Rock and steel can be cut by heat of any type, including conductive heat, radiative heat and heat-transmission by contact. This principle is used in the steel-manipulating industry. There such machines (translated from German) are called "burning-cutting machines". In addition, in principle, steel can be cut by heat-induced evaporation. As this requires more energy this principle is seldom used (some laser-cutting systems, laser-ablation-systems). What applies to steel applies to other materials, such as rock as well: Instead of destructing rock mechanically, rock can be cut through by heat, including conductive heat, heat-transmission by contact (touching with hot parts so it melts), radiative heat, heat by laser and other sources of energy. A drilling system consist thus of a ring of any shape (see below) with one or many, including hundreds or thousands, heat-producing elements, segments within the ring, such segments of 120° each or many small segments, including a grid of segments within the ring which have at their downward side heat-producing elements as well. The ring together with the segments melts or even evaporates (when intended) the rock. While doing so the ring, together with the segments, sinks into the rock, such as 10 cm, 0.5 m, 1 m, 3 m or more meters. Once the intended interim-target depth is reached at the base a ring, comparable to the adjustable lens-opening of cameras closes from other outside toward the center. To enable closing toward the center more heat-producing elements are attached. In addition, if a grid with heat-producing elements is employed within the ring after reaching target depth, comparable to the rollable frontside of a filing-cabinet, a line of heat producing elements moves horizontally beneath the rock while melting/evaporating it. This way the rock is cut off from the bedrock after interim target depth (10 cm, 0.5 m, 1 m, 3 or more meters) is reached. Depending on the geological situation the rock is held before cutting by an additional device (such as a cylinder that can shrink controlled, poles that protrude, such as melting, evaporation or other into the segments). This way the weight of the rock does not prevent the horizontal passing of the melting-device beneath the rock (closable ring, linear segments comparable to segments of a filing-cabinet and other).

**[0012]** To enable smooth operation the base of the ring is normally tilted: It has normally at least one deep and one high point with an inclination between deep and high point. In addition solutions with several deep and several high points are possible.

[0013] The base of the ring is normally curved upward, comparable to the roof of a plane. The heat that originates from the curved heat-segments of the ring results in a stream of molten rock that runs towards the deepest point of the ring by gravity.

[0014] At the deepest point the melt is sucked by vacuum into a heat-resisting pipe of several meters length (up to about 8 meters long for low-density rocks, about 4 meters length for rocks with density two, about 2.5 meters length for rocks with density three and so forth). After the target-level is reached the lower end of the heat-resisting pipe is closed. Te contents are then emptied into a heat-resisting and heated tank (closed or open) as they exist in the steel-industry. This way the pump that generates the vacuum does not necessarily be heat-resisting. Other means of transporting the molten rocks are possible as well. For evaporated rock a similar principle applies (evaporated rock guided in a heated environment into a tank where it condensates).

[0015] Parallel with drilling this way the cut segments (120°, more such segments or segments of a grid) are packed into heat-resisting containers (such as one segment of 120° in one such container). This prevents disintegration of the segments during transport upward. "Packaging machines" exist in various industries. The usage of this principle for drilling is new.

[0016] The packed rock-segments are then "handed" to a transportation-devices which waits above the drilling-device. After having received the containers with the "packed rock" the transportation device moves upward. The same applies to the "tank" of molten rock (passed to the upward device, an empty tank received from the upward device, either at each step or, for the tank, at intervals, such as every 20ths run a full tank is handed upward and an empty tank is received from above).

[0017] The transportation-device runs at the wall of the well, comparable to a vertical or subvertical toothrail-system. After having reached a certain elevation above the drilling-device, such as up to 100 m, 100-500 m, more than 500 meters, the (packed) rock is "handed" by the transportation-device to another transportation-device that is above the transportation device. The lower transportation device receives materials for covering the freshly drilled wall (metal, toothrails, electricity, LAN/WLAN etc.) from the higher transportation-device. Then the lower transportation-device returns downward to the drilling-system with materials for installation. The upward transportation-device proceeds higher with the rock to the next transportation-device or to the surface.

[0018] The downward-transported materials (wall segments, cables and other) are then installed at suitable depths, normally above the drilling system After they are installed the drilling-system can proceed further down.

[0019] This way, without any drillstring, circulation etc. depths can be reached until the limit of heat-resistance is reached. As heat-proof materials/heat-proof containers, such as for computers, exist, plus, where possible, with active cooling) 300-400° C. are easily reachable, even at 20-30 km depth. Transportation of the materials is done by a stafette-type elevator system.

[0020] Systems that pack, hand/pass materials are existing technology within the German handling-industry. They are new to drilling for which they can be adopted. LAN/WLAN, cameras, manipulators (to guide the whole system, install wall segments, both remote-operated and automatic) exists. Inside a well they are new in the mentioned way.

[0021] This (a) the whole drilling system is feasible and (b) it is innovative as nobody can easily reach great depths (20-30 km) at high speed of 0-1-4 or more) meters per minute(!).

[0022] The overall speed limit is limited by the speed of the transportation-system in connection with the speed of the installation of the wall segments. The speed of the drilling itself is limited by the amount of energy one wants to apply to melt/evaporate the rock (outer ring, segments, grid or even, although it seems impractical, the whole diameter).

[0023] The electricity is provided either by conventional cables/rails, as part of the wall segments or by an inductive cable/rail at the wall segments.

[0024] To monitor and steer the details (data for the software and/or an operator at the surface) the free space beneath each heat-element is measured (sound, radar and other). This way the electricity is adjusted spatially (around the ring, the closing ring at the base, the segments/grid segments) such that each heat-element receives only the electricity that is needed to melt the rock beneath it. This applies with the same logic to evaporation (such as by laser) and other alternative or combined drilling methods.

[0025] In the standard set up (as sketched above) the drilling system has almost no movable parts.

[0026] After the total depth is reached, such as some 10-30 km for geothermal steam for powerstations and some 6-10 km for geothermal steam for heating suburbs, the well is equipped with a longitudinal vertical wall. Cool steam moves downward on one side, hit steam moves upward on the other.

[0027] Deviated sidetrack-wells are theoretically possible as well. In reality they are likely to collapse over time in great depths due to lithostatic pressure. Thus a larger number of vertical wells for a large powerstation of the gigawatt-class will be the most economical solution (plus no downtime if one well needs maintenance).

[0028] In addition steel and rock can be cut by a variety of methods. To prevent legally tricky lawsuits other methods including combination of various methods including methods that appear unpractical are mentioned as well.

[0029] The patent has the title bitless drilling-system. Thus a tricky lawyer might recommend to attach a drillbit for decoration at the drilling device and claim that this solution is clearly with a drill bit although otherwise identical or similar to this.

[0030] Therefore now various other methods are mentioned that might be used for fast drilling, although they appear not as efficient as the sketched method.

[0031] Steel can be cut by high-speed (such as supersonic) water-rays. For cutting rocks this is occasionally reported as well. In addition abrading grains (quartz, corundum and other) can be fed into the water after it leaves the jets. This way the abrading power is additionally elevated.

[0032] What is said below in relation to water-jets applies in a suitable to heat/directed heat of various kinds (heat contact, radiative, even laser-ablation) as well. Combinations of heat/water/laser ablation might thus be used as well, even partially mechanical drilling with, for example micro-drill-bits in connection with water/heat etc. Tricky legal behavior is thus covered by such thoughts.

[0033] Straightforward engineers might thus focus on the core-concept as sketched above.

[0034] A ring with a large number of jets, such as every two millimeters a jet, ejecting water at a very high pressure, of two or more (or less) meter diameter cuts the rock in the shape of the ring. The jets can be fixed or movable, vertically or normally (such as 45° less or more) tilted.

**[0035]** In case of fixed jets the water-rays can be vertical (the exception) or tilted (the normal). While cutting the ring is subsequently lowered. The lowering of the ring and the tilting of the jets cause a ring-shaped cutting of the rock.

**[0036]** Particularly when the jets are fixed two or more adjacent water rays may intersect each other and thus enhance cutting the rock.

**[0037]** Of course the direction of the water can be steerable, either through movable jets, a second ray or steerable deviating bodies within the raypath.

**[0038]** The ring-shaped cut rock, for example a few millimeters, is vacuumed immediately away. The ring is lowered subsequently.

**[0039]** Thus, comparable to the coring process, only the outer ring is cut, not the whole diameter. The vacuumed rock (with the water) is either stored locally in a tank and transported later upward together with the core (see below); alternatively the rock (with the water) will be pumped up immediately or into a pipe or a hose inside the wall of the well (see below) or into a tank further up (the latter normally at the beginning of the drilling).

**[0040]** In addition to the ring (in phase one drilling only a ring is the normal) additional radii ("axes"), with jets, such as tens to hundreds of jets can be used. This can be, for example, three radii, 120° angular distance (ring plus radii result in the shape of a "Mercedes star"). This radii advance together with the ring downward. So three segments 120° each of for example 2-10 (more or less) meters length result. Once an intermediate depth, such as less than two, two-five, five-ten or more than ten meters is reached further jets cut the rock from the perimeter of the ring towards the center, comparable to the opening of the whole in a classical camera.

**[0041]** The three segments, 120° each and for example five meter long will be packed one after the other, such as in flexible but sturdy plastic, metal or other containers and transported one after the other (the normal case) or unsegmented (the exceptional case) upward.

**[0042]** In case of the upper ca. 100 meters the segments will be transported directly, without interruption, upward. In case of larger depths (ca. 100 meter to 20 and more kilometers) the segments are transported a certain interval upward, such as 100-200 m or more. Then the segments are handed to another transportation-device. This transportation-device transports the segments another 100-200 or more meters upward. After handing the segments to the next higher transportation-device it drives down and picks up the next segment at for example 120° of two meter diameter, 2-5 meter length. Such stafette-systems, e.g. systems that pass segments in a chain from one to the next, exist in many industries. Inside a well it is new.

**[0043]** The transportation-device/s drive/s at the walls of the drillhole, either in metal toothed racks (rails, comparable to very steep mountain-railways), in concrete toothed racks, in concrete toothed racks that are part of the wall-segments (the normal case), by friction or by other methods. In case of a water-filled or gas-filled (steam) drillhole uplift by the water or the gas can be utilized as well as additional or sole means of transportation too.

**[0044]** Such stafette-systems (e.g. systems that pass material from one to the next) are known technology in the field of "handling technology"—thus this invention works. Inside a drillhole this is completely new. This explains the comparison with anti-sliding systems of cars further above,

**[0045]** The transportation-systems will be supplied with energy either through a cable either standard-cable or induction-cable or combinations of both: after for example 100 meter drilling a cable, for example with connectors, will be installed in a canal of the wall-segments. Remote operated systems (such as ROVs, also with manipulators and cameras) are known technology within geology. Alternatively the energy will be provided by large capacitors (2500 F and more are known technology). They might be moved passively through the weight of downward-traveling water and concrete segments (for the wall). Combinations of methods, such as depending on the depth, are possible as well.

**[0046]** The water will either be transported in hoses (including hoses for hydraulics), in pipes (at greater depth (pressure) or temperatures or in tanks in above-mentioned stafette-way.

**[0047]** In case of tanks they can be dimensioned such that a sufficiently short rock-segment is pulled up by the weight of the water (plus steel and/or concrete wall segments) of the next higher transportation-device. Of course there still must be motors, for example for emergencies or remote-operated manual passing of the segments from one device to the next but the amount of energy reduces (cost-savings).

**[0048]** In case of hoses/pipes, for example every 100 m remote-operated installation of a hose-segment/pipe-segment into the wall, the weight of the water (hydrostatic pressure) enables in very shallow depths (4 km, e.g. the equivalent of the abyssal plains of the deep sea) a water-ejection at supersonic speeds.

**[0049]** In these cases the drilling-device (above-mentioned "ring") attached at the lowermost pipe-segment/lowermost hose-segment (hose in the sense of hydraulics hose) and the high water-ejection speed results without energy-costs.

**[0050]** Drilling with high-speed liquid (water, solutions/emulsions, other liquids), drilling by melting (many heat elements, instead of water-jets), drilling by evaporation (such as by laser) and combinations thereof, including drilling by piezoelectric impact, are thus from the logic used exchangeable and/or in combination. In reality drilling by melting will be the standard-way of fast drilling.

**[0051]** If the water is transported through tanks (emptying the tank of the upper transportation-device into the tank into the lower transportation-device or exchanging the tanks themselves together with, if applicable, exchanging large capacitors and/or charging/discharging them and handing concrete wall-segments down) then the drilling-device must have respective powerful pumps. Pumps and jets are existing technology. Shielding against the heat exist as well.

**[0052]** In many cases in shallow and medium depths (surface to a few kilometers) hardrock is not consistently solid but sometimes loose, such as through intercalated clays in sandstone, ash in basalt, even mylonite-zones in very deep situations, such as 60 km). Thus, after drilling (including cutting the segments) a flexible or solid "cover" (plastic "blanket", plastic container, metal container, ceramic container (for hot situations), a metal grid etc.) is pulled around the core/the core segments of 120° each/grid segments.

**[0053]** After cutting the rock off the bedrock the above-mentioned cover can be closed, such as comparable to the closing mechanism of a camera. In addition an outer ring can pull the core/each segment firmly together so in the majority of the cases the core (each segment) is held together by the pressing forces of the ring around it. In case of loose/semi-loose rock the cover must indeed be pulled around the core (each segment) by mechanical force even at its base. Other methods are possible as well.

**[0054]** The vacuumed/molten/evaporated rock of the outer ring (the drilled space between core and wall) and the radii (the distances between wall and center, each in 120° distance between each other) that resides after each drilled vertical section (0-2, 2-5, 5-10 or more meters) in a container (if not pumped into the wall, see below) is handed to the transportation-device above the drilling-device. An empty tank/container is handed down to the drilling-device in exchange. Other methods by which the vacuumed rock is pumped from tank to tank (when the core/the core-segment/s are passed upward in the stafette-system) are possible as well. Of course the vacuumed rock can be pumped upward inside the concrete-segments of the wall (see below) for example by several powerful concrete-pumps inside the wall (for molten rock: heated, so it keeps flowing). It is not expected that the standard-case might have a pipe in the wall for pumping molten rock.

**[0055]** Instead of alternatives several solutions can be employed in parallel/overalapping, such as depending on the depth and the respective situation. To prevent tricky legal argumentation this is mentioned as well.

**[0056]** Drilling-device and transportation-device have cameras, including cameras with different spectral properties (see below). In addition they have manipulator/s/handling device/s. This way for example loose rock that might have slipped out a cover can be moved into an additional "cover". "Cover" means everything flexible that withstands tearing/heating. Of course solid metal, grids, plastics (in case of low temperatures) or ceramics (in case of high temperatures) of for example 120° angle (cross-section like a triangle, the largest angle 120° or more, the hypotenuse (long side) curved according to the wall of the well) can be used as well.

**[0057]** Limiting to 120° implies that upward and downward transportation of loads (core-segments(upward), wall-segments(downward), if applicable water, capacitors, spareparts, sand(quartz, corundum) and other is easy in the stafette system (above items can be handed from one transportation-device to the next easily). In the field of "handling technology" such solutions exist. For a drillhole this is new.

**[0058]** Cameras and manipulators (including remote operated) ensure that small glitches (slipped parts etc.) can be compensated easily by the operator at the surface—even if they occur in 16 km depth.

**[0059]** In addition every 1000 meter there might be spaces in the wall: Upward moving core and downward moving wall-segments can bypass easily: The wall segments are disposed in the space. The core (segment) is handed to the upper device. The lower device picks up the wall segments and moves downward again. This way the core can even move upward unsegmented (cost savings by omitting cutting into segments, faster overall drilling as reductions of movements to one third). In addition such spaces might be designed according to the meeting point of rolling cable-cars in the mountains (transport of people for skiing): Upward moving core and downward moving wall segments move each a half to the side. They bypass each other uninterrupted. In the upper part of the drillhole this may be possible. In the lower part (6-20 km) the lithostatic pressure of the rock might prevent this (only vertical wells generally regarded as stable). The details exist in the field "handling technology". The introduction to deep drillholes is completely new. This explains the comparison with the anti-sliding system for cars.

**[0060]** If—for example (=but not limited to)—supercritical conditions are reached, e.g. depths with temperatures that are too high to liquify water by pressure, then, instead of water, other liquids can be used (and of course above mentioned melting/evaporation of the rock). In addition the water may contain substances (including the "other liquids") that change the boiling-point to higher temperatures. This is known technology. This way very high temperatures—expected—600° C. may be reached. Cameras, metal cylinders (instead of "covers"), possibly cylinders made of ceramics, jets etc. must in high-temperature cases (above ca. 350° C.) be isolated well and/or cooled actively. This is, as the mechanical forces are small, possible.

**[0061]** The drillhole itself (the wall) will be covered remote operated (including semi-automatic/automatic) by wall-segments 120° each (or more or less degrees). At these covering wall-segments (CWSes), for example CWSes made of steel/concrete, toothed racks (for example made of concrete as well) can be attached. At these toothed racks the transportation-devices and the drilling-device drives up and down. The CWSes may contain pipes, such as to conduct water for drilling or to conduct above-mentioned vacuumed rock upward. The same applies to guidance of power-cables (such as for the drilling-device, cameras, manipulators, illumination), data-cables, such as in the sense of LAN but normal cables that enable "classical switching" included as well (to steer the drilling-device, the transportation-devices), antenna-cables (such as to bridge the last few meters to the drilling-device by WLAN if no flexible LAN-cable is chosen). These "cables" (such as power, data) can be attached outside at the CWSes. They can be attached in a sort of "canal" that is part of the CWSes and protects the cables, such as against core-segments that might scrap at the wall in case of accidents and other. Induction cables/rails can be used for transporting electricity as well (touchless into the transportation device/s/drilling device/s).

**[0062]** The "canal" is filled with cables every, for example 100 meters. The works are conducted remote-operated or semi-automated or automated by the manipulators of the lowermost transportation-device and/or by the manipulators of the drilling-device. The mentioned cameras/illumination (see below) support this. This is known technology in parts of geology, such as for servicing pipelines in deep water. For drillholes this is totally new.

**[0063]** If the wall-segments are made of concrete (CWSes) they are resistant against temperatures until high temperatures. Other materials such as ceramics (for very high temperatures), metal (for medium high temperatures) or even plastics (for low temperatures) can be used for the wall as well. The same applies to composite materials.

**[0064]** After the planned total depth, for example for 300-350° C. is reached, in North West Germany, Sweden or the Midwest of the US this may well be 20 kilometers, a vertical wall, pipe-segments or combinations thereof are installed inside the drillhole remote-operated. These hole-segments (with vertical wall) and/or pipe-segments conduct water/cool steam (downward) and hot steam (upward). The remote operated installation ensures that for later servicing individual pipe-segments of for example 9 meters may be removed individually without pulling the whole pipe. This is new for drillholes. In reality it is expected that in the majority of the cases instead of pipe segments only a vertical wall will be installed inside geothermal wells.

**[0065]** If for illumination not only classical visible light is used, but also polarized light (against droplets, such as by steam, cause by groundwater, dropping down), active infrared, sound, radar then particles inside the well (dust, steam) are no problem.

**[0066]** As all, most or many of the works are conducted remote operated (including automated, semi-automated) the high personnel-costs at deep drillholes are lowered considerably: Less salaries but also reduced linked costs such as less living-allowances, less living-containers etc.

**[0067]** At the surface the steam is sent into a heat-exchanger, comparable to those that are used between primary (radioactive) and secondary (healthy) steam in nuclear powerstations. Here the primary steam comes from inside the earth. This ensures that in case of accidents the turbines get always clean steam so no consequential damages at the turbines can result from problems inside the well. The steam can be used further for heating houses (more heat exchangers) until it gets liquid. Alternatively the steam can be sent down immediately after the heat exchanger.

**[0068]** In cases of totally new sites (=no powerstation existing) shortly before the surface the diameter may extend from for example 2 meters to 60 meters. As hot steam has a much higher density then air several windturbines (or one with many blades, comparable to a propeller of a plane with many blades) can be used directly to generate electricity. If the wires of the generator are made of aluminium, CFK ("carbon-composite") or combinations thereof, weight and costs reduce. In addition rotating discs with suitable dielectricity-constants can be used as generators as well (low-cost high-voltage generation without step-up transformer).

**[0069]** If with this technology drillholes down to 150° C. are drilled for heating neighborhoods (suburbs) further cost-reductions apply: In contrast to water the hot steam comes up on its own. Thus no electricity for pumping is needed. If the steam is guided such through the neighborhood that below 100° C. the steam(water) flows only downward then no pumps are needed at all.

**[0070]** If deep drillholes are drilled only in tectonically quiet regions or into isolated blocks, e.g. blocks that might be surrounded by faults but such that no fault is drilled through then no cases of doubt regarding triggering of earthquakes can result.

**[0071]** Regarding drilling-technology deviated holes are possible as well. The deviations must however be quite early (3-5 km depth) as otherwise the load of the rock above (lithostatic pressure) might deform the drillholes in the deviated part.

**[0072]** Because the drilling method of this patent is very fast (one to several kilometers per day are possible, the bottleneck will be the transportation of the cores/segments) only vertical drillholes are recommended.

**[0073]** The use of toothed racks in the walls ensures that pipes for steam can be serviced remote-operated. Large diameters, such as four meters, are no problem as well.

**[0074]** The same applies for horizontal and subhorizontal drillings: Tunnels, drilled fast as cores. Now in case of drilling tunnels the whole diameter is cut. With the method of this patent only the ring is cut. The whole core and/or segments are pulled back and transported conventionally such as by trucks, an on-site railway (inside the tunnel) etc.

**[0075]** For questions of earthquake-studies, such as processes in the seismogenic zone off Japan (installation of instruments in the seismogenic zone) or for the next earthquake (still unreleased stress in Haiti) the method of the patent is suitable as well. The seismogenic zone is hot enough to allow transformation of non-lithified sediments (sand, silt, interbedded clay etc.) into solid rock. It is however "cold" enough (such as 600° C.) for the rock remaining rigid (non-plastic) so earthquakes can occur. With the method of this patent these extreme depths can be reached as well.

**[0076]** If the whole well is optimized for ultra-high temperatures (ceramic wall-segments, ceramic core-barrel (container/s for segments)/segment-barrel, composite ceramic transportation and drilling devices, optimized as outlined in the annex, drilling down to 1000-1200° C. might become possible. Then, this way, high-ovens for melting metal (iron ore, copper ore etc.) can be replaced by deep drillsites.

**[0077]** An important part of the bitless drilling-system is the integration of existing components such that something new results.

**[0078]** The claims do thus not address the single components: electric heating-elements are known since a long time; jets are as well used for high-speed liquid-ejection since a long time, such as in motors for cars. The, same applies to cables, WLAN, steel- and concrete wall-segments, motors, manipulators, cameras etc. The claims are similar to the claims for an anti-sliding system for car-brakes: The components had been known at the time of invention; the integration to something new was the invention. That nobody is able to drill routinely fast to 10, 15 20 or more km depth at a large diameter (such as 2 meters and more) shows the level of the innovation.

**[0079]** Here the invention makes for the first time ultra-deep drillholes (10-20 kilometers and more) economically possible.

**[0080]** Machines for short drillholes are not addressed by the claims. The same applies to machines that can be used for cutting rocks in quarries and machines where normally people can stand next to the machine in routine operation with normal clothing (impossible inside deep drillholes).

**[0081]** The claims apply only to drilling-systems for particularly deep drillholes (one kilometer to 14 and more kilometers) and/or holes that have a large diameter (above 1 meter) that are, amongst others, characterized by the following components:

**1**. System component one: Drilling-device

The drilling-device is characterized by:

One or more fixed or movable rings with one, several or numerous heating-devices (heat transfer by contact ("touch"), radiation, laser (incl. laser-ablation), for example every two millimeters, shorter or longer distances (of the heating-devices). The outer ring (in case of several) has on its outer (larger) side overall the diameter of the drillhole. The rings can be of constantly fixed shape. They might consist of variable segments that might be steerable, such as rotatable (such as, but not limited to, for maintenance-purposes) and/or retractable (such as in segments towards the inside) or both (rotatable and retractable). Other ways of moving, such as, but not limited to, flipping (such as but not limited to for maintenance inside the drillhole), are covered by the claims as well. While in standard-cases the ring will have an outer diameter of about two meters, smaller diameters, such as below one meter, one-two meters, larger diameters, such as three, four, four-six and more meters are possible and covered by the patent as well.

Although in general heat is the most suitable way of drilling the ring may alternatively/and/or in addition consist of one or more fixed or movable rings with numerous jets, for example every two millimeters, shorter or longer distances (of the jets). The outer ring (in case of several) has on its outer (larger) side overall the diameter of the drillhole. The rings can be of constantly fixed shape. They might consist of variable segments that might be steerable, such as rotatable (such as, but not limited to, for maintenance-purposes) and/or rectractable (such as in segments towards the inside) or both (rotatable and retractable). Other ways of moving, such as, but not limited to, flipping (such as but not limited to for maintenance inside the drillhole), are covered by the claims as well. While in standard-cases the ring will have an outer diameter of about two meters, smaller diameters, such as below one meter, one-two meters, larger diameters, such as three, four, four-six and more meters are possible and covered by the patent as well.

For standard-applications heat is regarded as the most suitable means. With heat very high temperatures, such as 400° C.m 600° C. or in the future even 1200° or more ° C. can be reached easily (heat resistant materials exist). Optionally in addition or alternatively, such as for very high temperatures, such as, but not limited to, above 350° C., additional to the jets or partially or fully alternatively to the jets, the rings may have small, movable (hammering and/or rotating) bits/chisels made of metal and/or ceramics and/or composite materials. Even with such small bits on the ring the system is still a "bitless" system as one single bit that hangs at a drillstring as in conventional oil-wells for example does not exist. The functionality (no drillstring, no pulling and inserting of the drillstring for coring etc.) remains as it is. The same applies to "cutting off the core", "packing it" (such as into a container made of metal/ceramics and/or composite materials), "transporting it upward" and so forth. The system remains mainly as it is; it gets enhancements to adapt it to certain environments.

It is mainly understood (a) as precaution against tricky legal argumentation and (b) as enhancement for ultra-high-temperature settings (350-1200° C. or more) that cannot be drilled with any drilling system on earth right now. Beyond scientific applications (such as studying the deep crust and the upper mantle) economic applications are the economic replacements of large ovens for iron-making by deep drillholes.

In addition this paragraph (optionally additional bits) is inserted to prevent legal tricks to circumvene the patent by carrying for example one or more small bits at the ring "for decoration" and/or "some" functionality with overall using the system as described in this patent but claiming that it is not "bitless" system.

During operation the heating-elements emit heat that is sufficiently high to melt the rock beneath the heating-elements at the intended speed of drilling (such as n moles Quartz per minute; energy determined by the melting-energy of quartz plus overheads).

The outer ring has at its base a variety of shapes, depending on the intention of the drilling-operation. In a standard-setting the ring has at least at its base one deep point and one high point. The claims apply to rings with several or many deep/high points as well. In a standard setting a cross section from the outer perimeter of the well to the center looks like: a deep lower base of the ring; a concave (toward the upper) bended (curve, planes etc.) inner part of the ring; at the top and/or in the respective shape (concave) the heating-elements; then followed again by a deep inner part of the ring. The ring consists of heat-resisting material (at least the lower part). Through heating the rock beneath the ring melts. Such as, but not limited to, the melt flows in the volume between the two diameters of the ring towards the deepest point. The ring is thus tilted, for example by 45 degrees, more or less. At the deepest point a heat-resisting pipe is attached. The melt is sucked, such as by vacuum, into the pipe. The diameter of the pipe and the length upward is determined by the volume it must hold per time unit. The vacuum-generating devices such as a pump, can be of non-heat-resisting material: The vacuuming stops once a filling-level is reached. Then the melt is lowered into an open or closed tank. In the standard situation the tank is closed and heated.

For standard-operation (to prevent non-heat resisting parts of the ring touch the melt and to save energy) at the base of the ring several devices to measure the distance between ring and rock are attached. These can be mechanical (heat-resisting pins) or non-mechanical, such as, but not limited to, echo-sounders from heat-resisting transmitters/receivers, radar and other. Alternatively/in addition the whole ring can be heat-resisting. Properties of the ring (such as, but not limited to shape) and other properties of the operation (such as, but not limited to, lowering of the ring) that are mentioned under below (operation with water) apply to the standard-operation with heat in a respective sense.

The claim applies to systems with several deep points and/or several pipes, several tanks as well. The claims apply to heated and non-heated pipes, including to tanks that are heated either consecutively or intermittently or both.

In case of water application during operation the jets eject water, other liquids (including solutions, emulsions), mixtures (of for example liquids and/or gases and/or solids(suspensions) that may serve certain purposes for example to increase the boiling-point. This/these various substances (water, liquids, solutions etc.) are in the whole patent addressed as "water" (with or without quotation-marks). The term water refers to the substance/s that is ejected from the jets during operation to cut the rock (including lithified, semi-lithified, non-lithified, semi-plastic, plastic(ductile) and/or even liquid rock). Man made materials to cut through such as concrete are not covered by the patent.

This water ("water" in above-mentioned sense) may in principle carry after leaving the jets (in principle before leaving the jets as well) solid (such as quartz-grains, corundum-grains and other) to enhance the abrading power. This water leaves the jets at high and very high speeds including supersonic speeds. This way the rock that is in front of the jets (colloquial: "downward in the drillhole") is cut.

The jets (as well as heating-elements) are, optionally, vertical or tilted, such as 45°. This way (particularly when tilted) the ring is lowered after the water cut a certain part (such as, but not limited to, one millimeter). The lowering can be in discrete intervals or continuously (overall uninterrupted) or both. During operation the space between jets and rock is measured so collisions between jet/s and rock are avoided. Steerable jets enable the targeted cutting of "micropillars" between the jets so heterogeneities of the rock are compensated.

The claims refer to rings (including but not limited closed, partially closed, open, including mixed forms) of any shape (circle, ellipse, square, polygon of any shape, multiple polygons, even emblems of countries can be drilled this way) that have (in case of circles) at least a diameter of half a meter. Arrays of smaller rings, particularly in case of irregular forms (above-mentioned "polygons") are covered by the claims as well. All these are referred to as "rings" although geometrically they might not be referred to as "rings" but something else. It distinguishes the rings ("rings" in above-mentioned sense) from methods with one drillbit and/or a drillstring and/or systems with one actively steerable motor instead of a drillbit.

The claims refer to rings that may or may not change there shape/form during operation and/or during pauses of operation either by themselves or intentionally steered (such as by LAN from the surface), intended (such as intentionally depth-depending, to compensate/accommodate for example one or more stress-regimes) or unintended ("tolerated").

The drilling-device is characterized by normally three but optionally one, two, four or more radii or grids or combinations of both that are have many heating-elements/jets (for water-operation), normally at the base but not limited to the base (such as slightly above the base, tilted) as well, such as (but not limited to) one heating-element/jet (water-operation) every 1-2 millimeters. These radii of different numbers (one, two, three, four or more) are from now on referred to as three radii. The same applies to a grid within the ring. In case of three radii in the strict sense (numerically three) ring and radii have normally the shape of a "Mercedes-star" (outer ring plus radii). Of course the radii may have irregular angles between each other (normally unpractical but covered by the patent). This way the core of for example two meters diameter is cut during drilling into three segments 120° each (in case of a grid for example, but not limited to several rectangular blocks and/or blocks that are partially rectangular (inside) and partially curved (at the outside of the ring). This (120° segments) applies to segments of about any angle. They are from now on referred to as "120° segments". Radii/grids that are equipped only with few or very few, even only one or no jet at all (such as to circumvene the patent by tricky argumentation) are covered by the patent as well. The important thing is a drilling-device that cores, does not use a drillstring and, as part of a system, can forward the core without pulling a drillstring towards the surface. Systems that cut the whole diameter away and pump the cuttings up are covered by the patent as well as long as no drillbit in the sense of oil-wells is used (one big drillbit hanging at a drillstring). A part is "no drillbit in the classical sense is worn down", "no drillbit needs to be replaced", the steering is done as described in this patent to high-depths (10-14-20 or more kilometers, such as, but not limited to, depending on the temperature can be reached). Such depths cannot be reached with classical settings at a high-speed with a large diameter (drillbit plus drillstring and/or motor-systems).

In case of diameters larger than two meters settings with people being able to stand near the drilling-device during operation are covered as well, such as for drilling tunnels—as long as it is done as described in this patent. The major difference to conventional tunnel-drilling systems is that conventional tunnel-drilling systems cut the whole diameter with one big drillbit (costly and slow). Here only small areas are actually cut (ring and/or radii and/or grid and/or combinations of both/several) and segments are transported upward/backward/towards the entrance of the tunnel.

The patent covers in addition to water (in above sense), multiple ultra-small bits along the ring, also other suitable methods to cut rock in the mentioned way (ring/segments) such as piezoelectric vibrations and other and/or combinations of methods, including above-mentioned heat, laser-ablation etc.

The important point is the reachability (in case of sufficient temperatures) of great depths/lengths (in case of tunnels) such as 1-10-14-20 or more kilometers by (overall) cutting cores/segmented cores.

The drilling-device is characterized by the fact that after reaching an intermediate depth, for example less than two meters, two-five meters, more than five meters, the core (the three segments) are cut at the bottom (in case of tunnels: at the reached penetration, colloquial: at the end) off from the rest of the rock.

In the standard case the drilling device holds shortly before the interim "end-depths", such as 0.5, 1, 3, 5 or more meters. It fixes the rock (holds it). It drills a short distance further down (such as some millimeters or less or more, even meters). It closes a ring, comparable to the closable ring of a camera, to cut the rock between perimeter and center. To cut the rock the closable ring has heating-elements/water jets operating towards the inside. In case of a grid inside the ring the grid segments move with the outer ring. Once the interim target depth in above sense is reached tilted panels with heating-elements/water jets at the lower side cut in each grid "rectangle". For simple applications the outer ring may be lifted several centimeters up: The heating elements of the outer rectangle cut then toward the perimeter even beyond the ring into the adjacent bedrock. This way rectangles of rock (curved outside) can be cut off simple. The cutting-elements (heat, water) might be guided like closable parts (many horizontal elements running around a 90 degree curve), moving first vertically then horizontally to undercut the rock.

For cutting the rock off the base a variety of methods, including mechanical, piezoelectric, heating, water and other can be employed. The patent covers all methods as long as they are used in relation to the drilling-device as described. The same applies to combinations of methods. Even small vertical drillholes (heated, by water, mechanical) that are used to insert poles with expandable parts to hold the rock and move the segments up are covered by the patent as long as they are used in relation to the drilling system. The task to move cut rock upward is not new. New is the employment of the method/s in relation to the drilling-system.

Normally the core (the three segments, grid segments) is either held for some time by a rope (including belt, very wide belt) that is bound tightly around the core. Alternatively/in addition a "shutter" like the device that determines the hole for the light (the aperture) in cameras that might follow the cutting device holds the rock (the three segments) above the bedrock for some time. The above-mentioned methods apply as well.

Irregularly cutting-mechanisms, for example those that disintegrate the rock while cutting into small pieces, although they appear impractical, are covered by the patent as well. Important for the patent is that a resting or "overall resting" core (in contrast to conventional rotary-cores) of a large diameter (half a meter to several meters) is cut off from the bedrock in a controlled or semi-controlled way such, that it can be packed as a whole or in pieces (such as the segments) for transport, such as, but not limited to, into containers (made of plastic (in low-temperature areas), metal, ceramics, composite materials, flexible coverages or even nets (such as, but not limited to, metal-nets).

This is one of several important components of the system: Conventionally after coring the whole drillstring has to be pulled to retrieve the core. This makes continuous coring down to for example 14-20 kilometers technologically and/or economically impossible. Here the core is packed for transport while and/or just after cutting it. It is subsequently handed to transportation-devices that pass it upward to the surface (see below). No drillstring is needed. Thus high penetration-speeds, both through cutting the core and overall transport/progress is achieved.

The drilling-device is characterized by the fact that normally while drilling and/or while/after cutting the core (the three segments) from the bedrock (the "remainder of the rock") a cover is pulled around the core (each of the three segments, grid segments).

This cover can be flexible but strong wrap/mantle/net.

This cover can be a container that is made, as it is appropriate (such as depending on the temperature) of plastic (low temperatures), metal (medium temperatures), ceramic (high temperatures) or composite materials.

Important is that this cover is pulled and/or pushed around the core (the three segments, grid segments) such that the core (the three segments, grid segments) can be transported upward in a controlled way, e.g. such that during normal operations no pieces fall outside the wrap, such that the core does not disintegrate such that problems occur (for example leave a net and fall down) and so forth.

The packing of material into wraps/containers by machines for transportation is as stand-alone technology known in many industries since a long time. The application inside deep drillholes is completely new. Thus the invention compares to anti-sliding (anti-lock) systems in cars: The components existed at the time of invention. The system itself was totally new. The drilling-device is characterized by the fact that the core (the three segments, grid segments) is either transported by the drilling-device itself to the surface (mostly at the beginning of the drillhole) or that passes the core (the three segments, altogether or one each) to a transportation-device just above the drilling-device.

The drilling-device is characterized by the fact that, if water is used instead of heat, generally depth dependent, the necessary water (in the sense of the claims) is either transported by the drilling-device itself (such as in a tank), passed to the drilling-device from a transportation-device above it or received through a connector/valve in the wall of the drillhole (see below). The same applies to the necessary energy (normally electricity): The energy is either transported by the drilling-device itself (such as in a battery, a large capacitor or another storage device), passed from a transportation-device such as by connecting or by handing a battery/a large capacitor from above, by plugging into a connector in the wall of the drillhole (for system-component "wall" see below, depth-dependent) or by one or more induction-cables, for example, but not limited to, at/in the wall-segments.

If water is used the pressure of the water is either established through the drilling-device itself (e.g. equipped with suitable pumps including piezoelectric pumps). Optionally (alternatives or in addition) the pressure forms hydrostatically by the water-column if the water is fed into the jets from the wall (10-20 km water-column can result in a pressure that generates supersonic speeds).

The drilling-device is characterized by the fact that it has devices for supervision (such as sensors, cameras, steering, microphones, manipulators) to address its components (such as repairs, freeing blocked pieces of rock, freeing possibly blocked wraps, plugging into the wall etc.), manipulating (repairing) the transportation-device/s, the wall etc. These can include illumination-devices (normal visible light, polarized light (such as against droplets of steam from dropping heated groundwater), active infrared, passive infrared, ultrasonic, radar and any other suitable illumination method.

This includes semiautomatic systems as well as fully automatic or manually operated (each movement steered by an operator at the surface). Normally the drilling-device is steered by LAN. This includes full or partial WLAN (such as by an antenna-cable as part of the wall, see below). A steering by explicit signals (no LAN but normal cables and switches) is covered by the patent as well.

The claims apply to "drilling-systems for deep drillholes" including for tunnels but not to the individual components such as manipulators, cameras, screws, LAN (the components are known since a long time). The invention is the drilling-system.

The drilling-device is characterized by the fact that it can remove the cut rock from the immediate drilling-region (e.g. the heating-elements/jets along the ring/the radii). In case of water normally it will be done by vacuuming (such as "sucking"). The removed ("sucked"/"vacuumed") rock/rock pieces will be vacuumed into a closed or open tank, such as of the drilling-device. Alternatively the removed ("sucked"/"vacuumed") rock pieces, such as but not limited to, together with the water that was used for drilling are fed into a pipe in the wall, such as through a fixed or flexible hydraulic hose, another pipe or another conducting mechanism, see below, system-component wall).

In case of heat the molten material flows to the minimum/minima of the ring. There it is sucked into (a) pipe/s of suitable diameter (such as to accommodate the volume of the ring for an intended depth-interval, such as 0.5, less or more meters). The vacuum is normally generated by a pump. If the melt is kept below the pump the pump does not need to be heat-resistant. As by normal atmospheric pressure only about nearly 8 meters of water can be hold for rocks with densities higher than water (the standard case) lower heights of melt can be held by vacuum. Thus the pipe/s has a suitable diameter. Alternatively one or more pipes are filled and/or emptied into a heat-resisting tank. The claim applies to both heated and unheated pipe/s and/or tanks. Once the tank/s is/are full it is either handed up to the transportation device, such as in exchange to an empty tank. Alternatively the tank is shortly heated so the semi-liquid rock slides easily out of the tank in a heat-resisting tank/container of the transportation-device. To prevent tricky legal argumentation the sentences apply to a variety of pipes (several minima), a heated pipe in the wall of the drillhole, heat-resisting pumps both/either at the drilling device/transportation device and/or in/at the wall-segments as well.

The drilling-device is characterized by the fact that while or after drilling, such as one or more or less millimeters it can move controlled downward/forward. This happens optionally in increments or continuously or both, such as steered by an operator or other means. The speed of moving downward/forward is normally adjustable. Fixed speeds are covered by the claim as well.

Drilling-progress will be supervised spatially resolved (such as between the heating-elements/water-jets), either mechanically or through other means. The results are used to optimize operation (remote-operated manual, semi-automatic, automatic) such as but not limited to by adjusting heat (consumption of electrical energy) water-pressure, water direction, activating (if applicable) small bits between the jets to eliminate micro rock-pillars etc. with the purpose to account for (amongst others) heterogeneities of the rock. Combined solutions (heat, water, microbits) are covered by the claim as well to prevent tricky legal argumentation.

The drilling-device is characterized by the fact that it has optionally devices (normally further heating-elements/water-jets with related components) to drill additional holes and/or caves into the wall (either the natural wall of the hole or the wall-segments as installed during operation, see below). The holes can serve to fix wall-segments made of steel or concrete or other materials (including holes for rock-anchors of varying length, from tiny to one or more meters). The holes can serve to accommodate appendices of the wall-segments. The holes can be, optionally, big enough to serve as storage place for concrete segments, water-tanks, tanks with quartz-grains (as explained above), capacitors, tools, spare-parts etc. that might be deposited there by downward moving transportation-devices (see below, operation of the transportation of cores and wall segments). Which types of holes are drilled into the wall is situation-dependent. In large depths, for example, caves for storing of material are impractical as they might collapse over time by the lithostatic pressure.

The drilling-device is characterized by the fact that it can, as part of its normal operations, drive actively up and down at the wall inside the hole. It thus does not hang at a cable from the surface. It drives actively, automated and/or semiautomated or manually controlled. This means that during normal operation the drilling-device does not hang at a drillstring or at a cable. Hanging at a cable is included in the patent as one possibility (such as for power-supply or as rescue-cable at which it might be pulled up either by a transportation-device from above or from the surface—although it is not practical (14 and more kilometers cable cause costs and have a weight).

The driving takes place normally through toothwheels at toothrails that are part of the wall and/or part of the wall-segments. Instead or optionally in addition other methods, such as those from chain-excavators, innovative steerable electrical "gluing and ungluing", upward forces (if the hole is filled with water or gas (such as steam); in case of gas suitable closing of the part beneath to maintain pressure), friction (pressing of wheels/"feet" or other devices to the wall) or other suitable means (such as stepping, controlled gliding) and/or combinations of methods.

In reality several methods will be installed, for example to have a backup method if toothed racks have at intersections an unplanned angle after some years due to faulty installation, if the drilling-device moves accidentally too far down below the lowest tooth-rack and so forth.

Didactical example (analogon): Imagine that the wheels for an inline-skating shoe can be steered individually up and down so small stones on the street are not felt by the skater as the wheels move individually up and down while passing over the stones. This way, in case of problems, several technological details (steerable toothwheels, various methods) are arranged.

The drilling-device is characterized by the fact that all components, depending on depth and conditions are sufficiently shielded against negative impact of temperature, moisture and other phenomena. Further shielding against falling rocks (nets/covers) are part of the drilling-device as well and as part of the drilling-device (including transportation-device, installation-device) part of the patent.

These can be passive shieldings (protecting containers, temperature-resistant materials). These can be, particularly at high and very high temperatures (from about 100° C. on but particularly above 350° C.) active coolings such as by evaporating liquids and through other methods.

The mentioned manipulators and/or tools and/or illumination enable the handling of incidents inside the well (such as fallen rocks, stuck warps and many other) such that in general the drilling-device does not have to come to the surface after an incident.

Limits:

The claims do not apply to machines for drilling through concrete—except as additional function of the drilling-device to install components inside the drillhole (such as by drilling small holes to fix pipes etc.).

Existing machines for drilling through concrete are characterized by the fact that during the drilling-operation (while the machine drills) people can accompany the machine to the total depth immediately at the site of drilling (such as a wall) usually without special protection (normal clothing for construction-sites, for example with helmet, gloves and/or glasses).

This (accompanying by people near the actual site of drilling) is in deep drillholes normally impossible (except in chambers, comparable to deep-sea submarines), for example due to the heat and/or the pressure (water vapor in 14 km depth) and other circumstances.

The claims apply however to drilling-systems for tunnels and or holes where one or more persons follow/s the drilling device downward if drilled with by core-drilling if the core has a minimum-diameter of one meter—even if people can stand in the tunnel a few meters behind the actual site of drilling. An important point is drilling by coring as mentioned in this patent.

**2**. System-component two: Moving-device

The drilling-device moves actively inside the well up and down.

This device (moving-device, transportation-device) is characterized by the fact that it has for example wheels (such as tooth-wheels that run on toothed racks). These toothed rack/s can be installed explicitly at/into the wall of the well. (such as, but not limited to, metal toothed racks). The toothed racks can be implicitly formed as part of steel and/or concrete wall-segments or by combinations of various methods. In case of toothed racks normally at least three (including less or more) toothed racks at an angle of normally about 120 degrees to each other are used. The patent applies to drilling-devices that move actively but without toothed racks, such as by using normal wheels that are pressed (such as using friction) against the wall of the well, moving devices like those of military tanks/excavators. The patent covers devices that use less or more than three toothed racks (in the sense of guiding-devices, even if they are in terms of engineering no toothed racks in the strict sense ("guidance systems of any kind" if guiding one or more drilling-device/s, transportation-device/s etc. inside a well). The patent covers also solutions that move the drilling-device and/or transportation-devices fully or partially swimming, fully or partially hovering (such as by using pressure of hot steam, for example caused by but not limited to heated groundwater). The formulation "guidance-system of any kind" implies: toothracks, rails, poles, combinations of protruding and/or canal-like ("longitudinal holes") etc. that serve the purpose that one or more moving-device/s/transportation-device/s and/or the drilling-device can hold at them to move up and down and/or to prevent falling down such that the intention of this patent (deep drillholes executed as cores and/or tunnels with normally two, at least one meter diameter executed as cores) is served. In case of low weights a moving-device/transportation-device/drilling-device might also hold at only one such guidance-device. Legal hint: The patent is written by a geologist, not by an engineer. All formulations are meant accordingly, e.g. such that the intended purpose is achieved—even though an actual guidance-device may not be a toothrack in the strict sense.

The patent covers also combinations of moving-possibilities. The transportation-device can thus be part of the drilling-device, an own device, part of the wall of the drillhole (for example the toothed rack) and/or part of liquids/gases and/or, which is excepted to be the standard case, a combination of both (device with wheels, running in a toothed rack which is part of the wall of the well).

The components that had been mentioned as part of system-component one, drilling-device (optionally individually steerable wheels, manipulators, supervision-technology etc.) apply optionally to the moving-device and/or to the transportation-device/s. The claims do not cover the individual components, such as toothracks. The claims cover a drilling-system for very deep drill-holes (including tunnels as mentioned) in the described sense that use toothracks as one of several components. Toothracks alone for example anybody can use as he/she wishes.

The drilling-device is characterized by the fact that it is able to drill a limited amount below the lower end of the toothracks, such as less than 5 meters, 5-10 meters or more than 10 meters.

The moving-device of the drilling-device is characterized by the fact that it can lower the drilling-device in a controlled way (such as: the moving-device hangs in the toothed racks; the drilling-device is lowered by a sub-system, for example, but not limited to, by a telescoping subsystem). Above-mentioned "controlled way" implies, for example, but not limited to, measuring the distance between jets and rock, eliminating, where necessary, micropillars of rock by heat and/or water-rays, tilted or vertical, or even by hammering or rotating "microbits", of a size from dentist-driller to hobby-drilling-machine, e.g. some 2 millimeters diameters, less or more).

For doing so the moving-device stops at an intermediate depth and lowers the drilling-device down, such as, but not limited to, at a telescoping-subsystem. The mentioned cameras, manipulators, handles etc. serve, amongst others, the purpose to readjust, remote-operated, the drilling-device into the toothed rack if, for example, it went somehow below its lowermost permitted depth so it derailed.

Limitation: Important is that the drilling-device is actively steerable, e.g. such that it does not hang passively at a drillstring (including cable hanging from above) like a normal drillbit does. Cables for power supply, data-cables are not excluded by the limit, e.g. such cables (LAN, power etc.) are part of the drilling-system.

Rescue cable/s such as to pull the drilling device up in case of a problem or to hang the drilling-device at a transportation-device to move it up for rescue-purposes are permitted as rescuing is not part of the standard-operations.

The claims apply only to drilling-systems for large depths (at least 200 meter total depth, in general 10, 14, 20 or more kilometers), in case of tunnels only to core-drillings with at least two meters diameter.

**3**. System-component three: Transportation-device

The drilled and (if applicable) packed cores/core-segments are passed from the drilling-device to a transportation-device that moves actively up and down inside the well (in general at the wall).

This transportation-device is characterized by the fact that

a) it can move actively inside the well, such as along the wall (remote-controlled, half-automatic, fully automatic),

b) can hold core/s and/or core-segment/s,

c) can transport, situation-dependent, material (such as water, cables, pipes, tanks, capacitors, segments of the wall of the well and other),

d) can pass both (core/core-segment/s and/or various materials, such as, but not limited to, as mentioned in the bracket of above point (c)) upward to the next transportation-device above of it or downward to the next transportation-device below it (stafette-like). It possesses the necessary manipulators/supervision-systems, such as cameras etc. to do the task. Optionally it possesses the mentioned equipment of the drilling-device/moving-device, e.g. cameras, handles, LAN, powersupply etc.

Optionally it possesses other equipment such as to drill small holes into the wall, fix equipment, do maintenance-work, rescue other transportation-devices or the drilling device, fix segments of the wall (see below, system-component: wall), install cables (such as for power/LAN and/or pipes, such as for water and/or steam and/or where appropriate, other purposes) etc.

The transportation-device can pass one upward-moving core-segment (the standard case) or core (the exceptional case) by (in the sense: along) downward moving other load, such as wall-segments.

Optionally, such as in low depths (some kilometers) the downward moving materials can be parked locally in a niche in the wall, so, for example, an upward moving core can pass unsegmented.

At least the lowermost transportation-device and/or the drilling-device (in the upper part of the well) is equipped with optional equipment (such as manipulators, handlers, cameras (polarized/unpolarized light, active infrared, radar and other) to install wall segments (see below) and other necessary equipment of the well. The equipment that was mentioned for the moving-device and/or the drilling-device may optionally in full or for some part be installed in the transportation-device/s.

The other optional equipment of the drilling-device, such as steerable wheels, apply to the transportation-device as well.

The stafette-type passing of material (core/s/core-segment/s, wall segment's, equipment) as part of the drilling-system ensures that each transportation-device has to move only a short distance up and down, such as, for example, one to three (e.g. all three segments directly behind each other in one go) times hundred or less to five hundred or more meters up and down to move core segments up and transport wall segments and equipment down (above-mentioned less than five, five to ten, more than ten meters serve as example).

Speed of transportation-device, speed of installation of the wall-segments and equipment and drilling are harmonized such that a quasi-continuous operation results.

The mentioned depth-intervals of the stafettes can be smaller or larger than the mentioned 100-500 meters.

Related side-aspect: The operation at the surface, such as steered with the help of wireless transmitters, GPS, infrared, radar, camera-guided optical systems or other means, to lay core/s and/or core-segment's in an appropriate way can be remote-controlled, semiautomatic, automatic with suitable devices (such as fork loaders) and/or the fetching and distributing of wall-segments/equipment, optionally remote-operated, semi-automatic, automatic (such as at night). A fully automated warehouse is state-of the art. As part of a drilling-system this is new.

The claim covers thus this side-aspect as well. This side-aspect can however be used by others too. This paragraph should only ensure that automated handling of core/s and/or core-segment/s and/or wall-segments and/or equipment cannot be forbidden by anybody.

Novelty: For remote operated warehouses such systems are state of the art. As part of a drilling-system this is new.

Limit: A classical core-barrel is not covered by the claim even though after packing by the drilling-device unsegmented there might be similarities to a core-barrel.

The major differences are: A core-barrels hangs at a drill-string that has to be pulled for each core. A classical core-barrel cannot be passed from one transportation-device to the next such as due to the drillstring.

**4**. System-component four: Energy supply

The drilling-system (drilling-device, moving-device, transportation-device, optionally pumps, tank/s, tools (remote-controlled, semi-automatic, automatic), cameras, manipulators, handles etc. are overall operated and/or controlled electrically. Other means are possible and are covered by the claim as well—although they appear less than optimal.

The electricity is passed in general, such as, but not limited to, by cables (including rails) in the segments of the wall, on the wall (on the "airside" of the wall compared to the "rockside"), in one or more canal/s of the wall (in the wall-segments) and/or through containers, such as large capacitors, batteries, induction-cable/s or other.

The term "airside" of the wall is understood throughout the patent as distinction to the "rockside". In case of a well that is filled fully or partially with a liquid, such as but not limited to water, the term "airside" refers then in fact to the "waterside".

**5**. System-component five: Water supply

In case of the standard-method, drilling with heat, this chapter applies only to a limited extent, such as to combinations of heat and water.

In case of drilling with water, the mentioned "water" (liquids etc. in above sense) is supplied to the drilling-device either through transportation device/s from above (such as by passing a tank, emptying a tank while meeting in the mentioned stafette-type way). Alternatively/optionally the drilling-device obtains the water from an outlet in the wall, e.g. every n meters one outlet into which the drilling-device can plug in (the last few meters then through a flexible hose, such as a hydraulic hose, a movable pipe or any other suitable device that can connect between wall and drilling-device and conduct the water, also sustaining the high water-pressure in great depths).

**6**. System-component six: Transportation of the cuttings

In case of operation with water the rock grains, that have been been cut off from the bedrock by the water in above sense (such as from above-mentioned ring and/or the radii), are normally immediately after cutting vacuumed ("sucked off") off the jets with or without (or partially without) the involved water. The vacuumed rock-fragments (including clay minerals, "mud") are either pumped into a tank of the drilling-device or pressed, such as through a flexible pipe/a flexible hose (including hydraulics hose) into the wall (see below). A pumping into a tank of a transportation-device (such as immediately above the drilling-device) is covered by the patent as well.

Optionally the tank/s (including drilling-device, transportation-device) can have components to separate water from the rock-fragments. This way the water can be fully or partially recycled. Optionally the grains (cuttings) are transported with water in tanks or inside the wall of the well. Combinations of methods, such as the upper kilometers through concrete-pumps and the lower kilometers through tanks are possible as well and covered by the claims.

claim **6** applies to combinations of heat/water as well.

**7**. System-component seven: Wall of the well

The wall of the well is characterized by the fact that it is part of the drilling-system.

The wall enables the drilling-device and/or the transportation-device to move up and down. Depending on the situation the wall transports energy (such as through cables), data (such as by LAN-cable) and water and cuttings, either inside the wall or on the wall (on the airside).

The wall of the well is characterized by the following components/properties:

In the standard-case the wall consists of segments (such as prefabricated steel or concrete-segments) that cover each one third (or more or less, such as a quarter) of the perimeter of the well in full or partially (if they are perforated). The segments have optionally controllable openings (such as covered by actively movable or passively movable (such as by the manipulators of the transportation-device/s, the drilling-device/s) flaps/covers. These segments are in many cases initially (=just after installation) part of a circle. Optionally they may have other shapes (ellipses, squares, polygonal shapes, such as to accommodate one or more canals, such as for the electricity cable, LAN-cable, downward water, upward cuttings etc.). The number and details of the shapes are not limited. Even cross-sections of the well that have the shape of a state-banner are covered by the claim.

In the standard case each segment has at least one toothrack, either additionally attached (at the surface or inside the well) or primarily made of steel/concrete, such as the same material as the segment/s itself/themselves, e.g. the steel/concrete has optionally a shape that it can act as toothrack. The term toothrack applies also to toothracks that have teeth on more than one side (such as, but not limited to, two, three or more), that have optionally longitudinal mini-canals partially behind the toothracks. An important property is that the effect of a toothrack/of toothracks is achieved even if the toothrack is no toothrack in the strict sense of engineering. In case of heavy loads, such as, but not limited to, core/s and/or core-segments, wall-segments for the standard-case the usage of three or more toothracks is expected. For lightweight cases, such as installing pipes and/or the mentioned longitudinal wall for downward water and upward hot steam the usage of one toothrack by each transportation-device is optionally possible. For doing this the toothracks are formed such that transportation-devices can hold at even a single toothrack such that they do not fall down. This way for example each toothrack can be used individually for upward and/or downward traffic (important, amongst others, for maintenance works).

The wall-segments can be made of suitable materials such as metal for medium temperatures, plastics for low temperatures or other materials such as concrete (universally, including high-temperatures and/or ceramics for ultra-high temperatures). Wall-segments of different materials (composite materials/combinations of materials) are covered by the claims as well. The claims apply regarding wall segments mainly to deep drillholes.

The wall-segments are fixed at the natural wall of the well (in the sense of the rock, including non-lithified, semi-lithified or lithified rock of any kind) either by the drilling-device (such as with above-mentioned manipulators, handlers, optionally supervised through above-mentioned cameras) or through the lowermost transportation-device (and its equipment, such as, but not limited to, manipulators, handlers, cameras and optionally more) or through other suitably equipped device/s/transportation-device/s. To support fixing the wall-segments may have protruding poles ("pillars") that may fit into drilled cavings of the natural wall (such as, but not limited to, by suitable, optionally steerable, heat-elements/water-jets, even piezoelectric/mechanical including combinations thereof that are directed to the side (including horizontal, upward or downward tilted or tilted in various directions including curved) and drill when and where appropriate). Support of the installation (fixation at the wall) is optionally possible through rock-anchors, normal or specialized cement, including deep-drilling cement, concrete or other suitable technological means.

The fixing (installation of the wall-segments at the natural wall) is either done remote-controlled manual (such as by a person at the surface, being at controls and camera-supervised), remote-controlled semi-automatic, fully automatic and/or combinations of these (such as changing, depending on the situation) or even locally remote-controlled (steering by software from the drilling-device but done by the lowermost transportation-device, for example, optionally, to have computers centralized). A steering comparable to missions in deep space (automatically steered by navigating with stars, manually steered when reaching the target) is thus covered by the claim as well.

Important (explanation of the term "remote-controlled") that for installation of the wall-segments in the standard-case there are no persons inside the well (that, for example due to the temperature, cannot be inside the well anyway in great depths), for example to drill a hole into the natural wall, fix a wall-segment, add cement to it and so forth. All this is done by the devices that run at the wall of the well (drilling-device/s, suitable transportation-device/s, such as, but not limited to, the lowermost transportation-device). The actual works are done through manipulators/handlers.

This type of approach is in other parts of geology state-of-the art, such as for maintenance works of deep-sea pipelines. Inside a well it is new. A drilling-system of this type, the wall being part of the drilling-system (guiding drilling-device/s, transportation-device/s, water, energy (electricity), data (LAN)/WLAN), is new (this patent). The claims apply to the drilling-system for deep drillholes and to horizontal drillholes of at least two meters diameter, executed as core-drilling. The claims do not apply to pipeline maintenance.

Depending on the situation (depth, purpose of the well, such as for geothermal steam) the wall-segments can have canals/conduits in vertical (including overall vertical, tilted, subhorizontal, horizontal, straight or curved or both) into which equipment is attached/inserted/fixed. Example are (not limited to): pipes/hoses (such as, but not limited to, for water, including outlets/plugins in suitable depths, valves for pressure reduction and other appropriate equipment) and/or cables (such as, but not limited to, for electricity, data (LAN /WLAN), cuttings (with or without water, e.g. optionally mud and/or dust), pumps for the mud/dust and other devices (WLAN-bridges, to transmit, where appropriate, optionally, data to and from the drilling-device/s, the transportation-device/s, for example images of cameras, sound, measured values, commands etc.). These components of equipment are installed for example by the mentioned manipulators.

The segments (such as, but not limited to, one of several of the well-perimeters can optionally be particularly thick, to have, for example, but not limited to, at the airside of the well, space to accommodate above-mentioned equipment.

Formulated didactically compact (start of didactical example): All such spaces of each particularly thick segments, viewed together vertically from the top, form/comprise a vertical "canal" into which the equipment is embedded. Two or more canals or canals in more than one segment along the perimeter, such as for example water conducted in pipes in one canal, electricity and data (LAN) conducted in cables in another canal, are possible as well. The example is didactical.

The installation of for example 100 meter new pipes/cables etc. can for example be the last step (drilling, installing the wall-segments) after drilling these 100 meters and installing. The drilling-device, for example, unplugs at the upper plug (electricity/water), moves down, plugs into the lower new plug for electricity/water, plugs into the new plug for electricity and data (LAN), moves up 100 meters again, unplugs the upper electricity connector, unplugs the upper data connector, unplugs other connectors as appropriate (such as to move cuttings into the wall), moves down and continues to drill after all connectors are plugged into the lower connectors as appropriate. The sentences apply to induction cables and/or drilling without water (e.g. with heat) as well.

End of didactical example.

The term "cement" (appropriateness of the patent) applies to "all suitable cements of any kind, including substances that formally may not be cements but serve as cement, such as suitable glues, suitable concrete, including deep-drilling cement that solidifies under water (for example but not limited to in the sense of oil-wells). Mechanical fixings are thus summarized under the term cement as well.

Wall-segments (including toothed racks) are installed near-time (remote-operated, semi-automated, automated). Pipes and cables are installed after some progress, such as 100 meters. The intervals after which pipes and cables are installed can be shorter or longer than 100 meters, such as 20 meters or less, 200 meters, 500 meters, 1 kilometer, more or less, depending on the situation.

The need to install wall-segments, pipes, cables etc. explains the fairly low drilling-progress of less than one to some kilometers per day. Considering the high amount of heat-emitting elements/water-ejecting jets drilling progresses (cores(!)) of one meter in 10-60 seconds (e.g. one meter per minute), e.g. 1.4 to 8.6 kilometers per day(!), e.g. 24 kilometers in about three days should be expected. The interruptions for installations (such as wall-segments, water-pipes, cables etc.) cause lower overall progresses.

Depending on the purpose of the well the segments have on the airside handles/holes/caves/holders for purpose-specific equipment, such as pipes for downward water and upward steam, cameras and microphones (for supervision), electricity and data-cables (if the primary ones remain reserved) etc.

The transportation-device/s and/or some transportation-device/s and/or specific transportation device/s (for example outfitting device/s) install the equipment (such as pipes) remote-controlled, semi-automated, automated, either from the bottom to the top, or, through smaller transportation-device/s ("outfitting-device/s") that do not transport core-segments but only pipes and equipment and that thus can hold at one or a small number of toothed racks only because they have, amongst others, a small weight. This explains why the toothed racks can have a variety of shapes as outlined above, e.g. serving transportation with, for example, three toothed racks as outlined but also serving installation and/or maintenance in a semi-full well, so only one or two toothed racks are available for guiding a transportation-device.

The purpose-specific equipment can be serviced remote-controlled as well due to the toothed racks and respective transportation-devices with cameras, manipulators etc, for example other transportation-device/s that hold onto one single or more toothed rack only (to compensate for the space that is occupied by the purpose-specific equipment) and so forth.

Such deep drilling-systems are completely new.

This explains the high level of the invention: Most components, such as pipes, cables, jets, cameras, LAN exist. By putting components together in an intelligent way a new system results.

**8**. Optional addition one:

The system-components "wall of the well", "transportation-device", "moving-device" and optionally "drilling-device" have an optional extension that is characterized by the following properties:

Transportation-device/s, moving-device/s and/or drilling-device/s are equipped such that they can pass by each other when moving up or down. This implies: An upward transported core, unsegmented, can bypass a downward moving transportation-device that, for example, carries wall segments. This implies that for example the downward moving transportation-device moves "partially folded", e.g. such that the wall segments are stacked vertically so it occupies less area of the diameter.

This is achieved by an intentional local thickening of the well and/or, in principle, a larger diameter (in general the larger diameter appears impractical but it is included in the patent). In case of a local thickening of the well upward and downward moving transportation-devices deviate each (or one) partly or fully to the side, comparable to the "meeting-point" of cable-cars to mountains. Walls, toothed racks and other equipment are adjusted accordingly.

For shallow depths this is expected to be possible in many cases, such as, but not limited to, in granite. For large depths a situation-dependent analysis has to be done as the lithostatic rock pressure may collapse the thickenings.

The advantage of unsegmented rock transport (effectively faster) has to be counted against stability of the thickening/s and/or a generally larger diameter.

The patent covers drilling-system/s for large depths. For drilling-systems it is new. For cable-cars similar solutions are known since a long time.

**9**. Optional addition for ultra-high temperatures, for example to reach temperatures in the range 350-500-1200° C.

For ultra-high temperatures (350-500-1200° C. or more) the drilling-system is optionally characterized by the following properties:

Optional further properties:

For high (350-600° C.) and/or very high temperatures (600-1200 or more ° C.) the wall-segments (including, optionally, where appropriate, pipes, cables etc.) can be made of particularly heat-resisting materials such as ceramics. They may or may not have elements for active cooling so and or, optionally, horizontal separation-elements (colloquial: doors) so heat from the lowermost part of the well stays only in the lowermost part of the well and does not enter the whole well, for example to melt ore in the well.

In above-mentioned temperature-regime, in the standard case drilling is done only by heat. Optionally, to prevent tricky legal argumentation, in addition to "drilling by heat" in case of "drilling by water" or combinations of heat/water, the "drilling" is done by manipulators/handlers, many small(!) bits on the ring/the radii that either hammer or rotate or do both or do other suitable actions

The drilling-system is this way of course still a bitless drilling-system, because it does not have one single drillbit that hangs at a drillstring (and is not able to stand the heat). The many small bits, hammering or rotating or doing other movements replace optionally in situations with high and ultra-high temperatures the water in above-mentioned sense.

All the rest (such as "core with/without radii", transporting the core etc) is done as described. The many small bits are made of temperature-resisting materials, such as ceramics and/or composite materials. Of course other means to disintegrate rock, such as, but not limited to, piezoelectrically induced vibrations (such elements in addition to/instead of the small bits) are covered by the patent as well.

The same (temperature-resisting materials) applies to the drilling-device/s (wheels, rings), the transportation-device/s, packaging of the core/s and/or the core-segment/s, shielding of computers, temperature-resisting glass of cameras and other equipment (normal metal gets weak at such temperatures).

This explains the differentiation between normal temperatures (up to about 250-300-350° C.) and high and ultra-high temperatures.

For high and ultra-high temperatures the progress is expected to be low.

The most important point is to reach such temperatures "at all", for example to replace a large oven of a steel-company by some or more ultra-deep wells or wells to shallower depths in high-temperature areas.

The drilling-system works in high and ultra-high temperatures as described in this patent. In case of "drilling by water" the water (as described) is in high and ultra-high temperature regimes optionally replaced by other suitable means, such as many small bits at the ring/the radii, many piezoelectrical elements at the ring/the radii and so forth.

One big single drillbit as in classical oil-wells is not used (the drillstring would get soft or possibly melt in such high and ultra-high temperatures). Thus, also in high and ultra-high temperature regimes the drilling-system is still a bitless-drilling-system as described.

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