(19) Europäisches Patentamt
European Patent Office
Office européen des brevets

(11) **EP 2 949 859 A1**

(12) **EUROPEAN PATENT APPLICATION**

(43) Date of publication:
02.12.2015 Bulletin 2015/49

(21) Application number: **15169672.1**

(22) Date of filing: **28.05.2015**

(51) Int Cl.:
E21B 41/00 *(2006.01)* ***E21B 7/02*** *(2006.01)*
E21B 44/00 *(2006.01)* ***E21B 21/015*** *(2006.01)*

(84) Designated Contracting States:
AL AT BE BG CH CY CZ DE DK EE ES FI FR GB GR HR HU IE IS IT LI LT LU LV MC MK MT NL NO PL PT RO RS SE SI SK SM TR
Designated Extension States:
BA ME
Designated Validation States:
MA

(30) Priority: **30.05.2014 IT MI20141011**

(71) Applicant: **Soilmec S.p.A.**
47522 Cesena (FC) (IT)

(72) Inventor: **DITILLO, Alessandro**
47522 CESENA (FC) (IT)

(74) Representative: **Biallo, Dario et al**
Barzanò & Zanardo Milano S.p.A.
Via Borgonuovo, 10
20121 Milano (IT)

(54) SAFETY SYSTEM FOR CONTROLLING A DANGEROUS AREA OF AN EXCAVATION MACHINE AND EXCAVATION MACHINE COMPRISING THE SAME

(57) Safety system for controlling a dangerous area of an excavation machine (1) provided with a guide antenna (3), a rotary head (5) coupled in a sliding manner on the guide antenna (3) and arranged for supporting and moving an excavation battery (6), the safety system comprising:

- a shield (9) couplable with the machine (1) so as to extend in a substantially radial direction around the excavation battery (6) defining an upper area of the guide antenna (3) and a lower area of the guide antenna (3) where the excavation occurs, the shield (9) being shaped so as to stop the raising of the material projected from the lower area towards the upper area.
- a plurality of sensitive devices (8) intended to be positioned in the upper area and configured for generating a monitoring area, for detecting the presence and/or the passage of a body in the monitoring area and for generating, following such detection, a corresponding control signal adapted to at least stop the rotation of the excavation battery (6), said sensitive devices (8) being arranged on the machine (1) so that the monitoring area at least partially comprises the dangerous area.

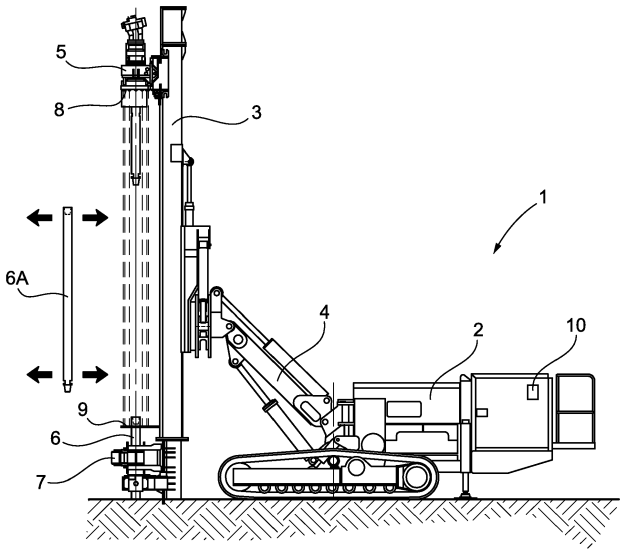

Fig. 1

EP 2 949 859 A1

Description

[0001] The present invention concerns a safety system for excavation equipment particularly but not exclusively used in an excavation machine for controlling the dangerous area surrounding the machine and for interrupting the dangerous manoeuvres of the machine itself.

[0002] The present invention also concerns an excavation machine comprising the aforementioned safety system.

[0003] More specifically, the safety system, according to the present invention, is used to prevent an operator from coming into contact with rotary or moving members of the drilling machine that are directly involved in the excavation process.

[0004] Indeed, the field of application of the present invention is that relating to excavation machines that, operating in several technological fields, can require the personnel in charge of the auxiliary services to carry out manual interventions in areas around the machine that are exposed to dangers, in particular close to the guide antenna or mast on which the rotary head or rotary slides and close to the drilling axis on which the shafts used for the excavation, mixing, jetting and driving-in processes are located. Excavation machines require interventions of the personnel that can be generally divided into three types: first mounting interventions, maintenance interventions and interventions simultaneous to the work manoeuvres. In the first two types of interventions, usually carried out in the factory, the experience of the trained personnel, the specificity of the problems and common practice lead to consider this step not to be particularly risky. In the third type of intervention, in which manual interventions are required during the work steps, for example to add or to remove the drilling shafts limited to the area close to the mast, the exposure to risk is very high since the operations are carried out on moving parts and are routine and this physiologically generates a drop in attention by those carrying out the same action repeatedly; moreover, such interventions must be quick, so as to reduce as much as possible the intervention time and increase productivity.

[0005] In the present description by dangerous area we mean the region of space around the guide antenna where the rotary head slides and the region of space close to the excavation area.

[0006] For these reasons, in order to allow the operator, during the normal operations of the machine, to access the mobile parts of the machine itself that are directly involved in the excavation process, the presence of protections is suggested, such as fixed barriers or guards, mobile barriers or guards with interblock, sensitive protection devices or a combination thereof around the dangerous area. Such protections must prevent access to the dangerous area during any dangerous movement.

[0007] For example, document WO 2011/051564 describes an excavation machine that comprises a protective structure or shield arranged at least partially around the antenna.

[0008] In the case in which the mobile barriers are opened or if the sensitive protection devices are activated by the entry of an object into the dangerous area, the dangerous drilling manoeuvres must be blocked quickly and safely: the standards require at least the rotation of the shaft to be instantaneously blocked and, alternatively, both the rotation and the translation movements of the driving head to be simultaneously and instantaneously blocked.

[0009] All the while that the mobile barriers remain open or that the sensitive devices remain activated, it is possible to reactivate the rotation of the shafts and the sliding of the rotary just by selecting, through a proper selector, a limited operating mode. In this limited operating mode all manoeuvres are properly slowed down up to values such as to eliminate the danger and to allow the inspection of the parts or the execution of the manual interventions. In order to go back to the normal operating mode, i.e. the work mode, it is necessary to have closed and reset the interblocked mobile barriers or to have the sensitive protection devices no longer active and to have them reset, to have the normal operating mode selected, through a proper selector, and to have the start-up command actuated.

[0010] It is known in the field to use mobile guards with interblock, made in the form of containment cages, arranged around the work members of the machine to isolate the dangerous area. Such containment cages generally consist of one or more supporting frames, made through shaped tubes or plates that constitute the external shape thereof, and of metallic or plastic grids or meshes or other shields that occupy the area enclosed by such a shape. The supporting frames can for example be hinged at points integral with the mast so that they can open by rotating on the horizontal plane, when the mast is arranged vertically, and leave free access to the dangerous area.

[0011] These types of barriers or "guards" in closed position, i.e. in work condition, have considerable bulks that generally are greater in the horizontal direction than the shape of the rotary head or of the clamps in order to be able to receive the rotary head inside the protected volume. Such bulks are linked to the need of delimiting a sufficiently large dangerous area, i.e. of keeping the operator sufficiently far away from the danger represented by the rotating shafts.

[0012] Moreover, the possible presence of mechanical loading-aid means has to be provided, like for example automated loading arms, the so-called rack or revolver loaders, or the articulated cranes, which, in order to be able to operate correctly, should be contained inside the protected volume defined by the barriers. The aforementioned considerable bulks, however, for various reasons, constitute a great limitation of the operating capabilities of the machine. In particular, such bulks do not allow performing drilling close to walls or corners formed by two walls, since by bringing the machine close to the

walls a contact of the barriers with such walls occurs, preventing a further approach of the drilling shafts. In this way, it would not be possible to carry out any "wall-flush" drillings typical of consolidation and restructuring works.

[0013] In the same way, in order to be possible to open the barriers, it is necessary to have enough space around the mast to allow the rotation or translation movement without interferences with obstacles during the trajectory of the movement.

[0014] The presence of the barriers, therefore, represents an obstacle to the manoeuvres and is limiting for the drilling that can be carried out.

[0015] The aforementioned limitations are not compatible with the confined spaces of building sites in which drilling machines generally work, in particular in an urban environment, in which the agility of the machine is essential. The bulk of the barriers, also in the open position, hinders the step of adding or removing shafts in the drilling battery.

[0016] Moreover, the need to carry out continuous opening and closing of the barriers for loading the shafts determines an increase in work time and requires complication of the hydraulic and electrical system to manage the actuation of such barriers.

[0017] A further limitation of this solution consists of the increased weight of the machine, with a consequent reduction of the stability due to the frontally cantilvered positioning of such barriers.

[0018] The use in horizontal drilling (tie rods) with very low heights, less than 1.6 m, would also force to arrange barriers for the entire length of the mast, to always protect the operator in any position he is. In this case, however, these barriers would have points of contact and interference with the ground and would make the loading of the shafts awkward, since the mobile parts for the access to the shafts are considerably heavy, since the length of the shafts themselves can even reach ten metres.

[0019] An alternative known solution consists in using sensitive devices, such as electrosensitive, photosensitive, laser, optical, radar, ultrasound or thermal devices. Such devices are arranged to generate a monitoring area that in turn at least partially comprises the dangerous area and to detect the presence and/or the passage of a body through such an area.

[0020] In the case in which an object passes through such monitoring areas, such passage triggers the sensitive devices causing the stop of the functions of the machine. This solution also has some drawbacks. Such drawbacks occur, in particular, during drillings carried out through air supply (in deep hole drilling with hammer, commonly known as DTH) or water (tricone drillings or with hammers at the head and rotopercussions) or cement (injection and jetting) or during the mechanical mixing of the ground. During drilling or mixing, indeed, a lot of debris is projected from the excavation upwards due to the injection pressure or to the movement of the shafts. In the same way, sprays of water, mud or cement can be projected upwards. Such debris or sprays during their movement, therefore, can cross the monitoring areas by the sensitive devices. Such crossing can occur both from the excavation axis towards the outside of the dangerous area but also from the outside of such an area inwards due for example to the bouncing of the debris against the parts of the machine, for example against the mast. The crossing of the debris or of the sprays of water, mud or cement causes an undesired triggering of the sensitive devices and consequently the stop of the machine even in the absence of an actual condition of danger due to the passage of people. This can lead to continuous stops of the machine, seriously slowing down work, also considering the length and complexity of the operations imposed by the standards for reactivating normal operating mode. Purpose of the present invention is to make a safety system for an excavation machine that overcomes the aforementioned drawbacks of the prior art, minimising the possibility of undesired stops of the machine in the absence of dangerous conditions whilst still maintaining the maximum reliability in detecting conditions of actual danger.

[0021] Another purpose of the present invention is to make a safety system for an excavation machine that is simple to be installed and that can be applied to different types of machines.

[0022] A further purpose of the present invention is to make a safety system for an excavation machine that is cost-effective and that does not limit, due to its size bulk, the capabilities in terms of excavation and of the approach to obstacles or walls.

[0023] Yet another purpose of the present invention is to make an excavation machine that ensures a high safety degree for the maintenance interventions to be carried out during the excavation process.

[0024] These and other purposes according to the present invention are achieved by making a safety system and an excavation machine as outlined in the independent claims.

[0025] Further characteristics of the safety system and of the excavation machine are the object of the dependent claims.

[0026] The characteristics and advantages of a safety system and of an excavation machine according to the present invention will become clearer from the following description, given as an example and not for limiting purposes, referring to the attached schematic drawings, in which:

- figure 1 is a schematic side view of an excavation machine according to the present invention;
- figure 2a is a schematic partial side view of a first embodiment of an excavation machine according to the present invention;
- figure 2b is a schematic partial front view of a first embodiment of an excavation machine according to the present invention;
- figure 3a is a schematic partial side view of a second embodiment of an excavation machine according to

the present invention;

- figure 3b is a schematic partial front view of a second embodiment of an excavation machine according to the present invention;
- figure 4a is a schematic partial side view of a third embodiment of an excavation machine according to the present invention;
- figure 4b is a schematic partial front view of a third embodiment of an excavation machine according to the present invention;
- figure 5a is a schematic partial side view of a fourth embodiment of an excavation machine according to the present invention;
- figure 5b is a schematic partial front view of a fourth embodiment of an excavation machine according to the present invention.

[0027] With reference to the figures, an excavation machine is shown, wholly indicated with 1. Such an excavation machine 1, in particular, is suitable for all digging technologies by rotation, rotopercussion, vibration, rotodriving and mixing and injection and it can be of the type for making piles, micro pile supports, tie rods or mechanical mixing.

[0028] The excavation machine 1 comprises a machine-base 2, equipped with tracks or wheels, which allow the movement on the building site, a guide antenna or mast 3 and a linkage 4 that allows the movement of the antenna 3 with respect to the machine-base 2 to take it reversibly from a closed configuration used for transportation to a work configuration, in which the antenna 3 can be arranged vertically, inclined or horizontal.

[0029] The guide antenna 3 is slidably coupled with at least one rotary head 5 or rotary, arranged to support and move an excavation battery 6 that comprises at least one drilling segment or shaft 6A; in detail, the rotary head 5 is coupled with the antenna 3 so that it can slide along the antenna itself to cause the excavation battery 6 to move forwards or backwards during drilling.

[0030] On the rotary head 5 an excavation battery 6 can also be mounted, which uses percussion and/or vibration in addition to rotation.

[0031] Preferably, the excavation battery 6 can comprise at least one supplementary segment or shaft 6A that must be added during drilling, in particular when the excavation or treatment depth that is wished to be reached is greater than the stroke of the rotary head 5. In this case, during excavation, at the end of the first stroke of the rotary head 5, it is necessary to disconnect the rotary head from the last drilling driven in shaft 6 and to lift it in order to add one or more supplementary shafts that are screwed on those that have already been driven in. In order to allow such an operation, at the base of the guide antenna 3 there is at least one pair of clamps 7 that allows holding the last drilling driven in shaft 6 and disconnecting the rotary head or a shaft from it. The at least one pair of clamps 7 can comprise a pair of gripping clamps 7 or alternatively a gripping clamp 7 of the unscrewing type. The at least one supplementary shaft 6A is thus connected to the battery at a height above the clamps. In the case of double-head drillings both the shafts and the coating tubes (externally coaxial to the internal shafts) are used and these require the application of three clamps, at least one of which is of the unscrewing type.

[0032] At the end of the excavation it is necessary to repeat the aforementioned operations in reverse in order to extract the battery by unloading the shafts in sequence. The steps of loading and unloading the shafts can require, for the correct positioning, the intervention of an operator who must therefore get close to the drilling axis, in order to lift them or at least to direct them with respect to the shafts 6 held by the clamps 7. The maintenance, inspection and replacement operations of the digging tool can also require the operator to get in said area. The area close to the guide antenna 3 and to the excavation battery 6 is considered dangerous, since the operator could come into contact with the rotary members and consequently could get caught in them and be dragged. Another danger can be caused by the movement of the rotary head along the guide antenna, which could hit or drag the operator.

[0033] In order to avoid the operator or other building site personnel being exposed to dangers during the aforementioned steps, according to the present invention, the excavation machine 1 is provided with a safety system for controlling the dangerous area.

[0034] Such a safety system comprises a plurality of sensitive devices 8 configured to generate a monitoring area and to detect the presence and/or the passage of a body in such a monitoring area.

[0035] Preferably, the sensitive devices 8 can be of the electrosensitive, photosensitive, optical, radio, laser or thermal type.

[0036] In any case, such sensitive devices 8 comprise a signal emitter (not illustrated), for example an emitter of an electric signal, or of a light beam, of a thermal beam, of an ultrasound beam, of a radar beam, of an optical beam, and so on, and a corresponding receiver or reflector component (not illustrated) and are configured to detect when an object intercepts the signal emitted. Such signals are indicated in figure 1 with a broken line.

[0037] The path of the signals between the emitter and the receiver or reflector component defines the monitoring area within which the devices are able to detect the presence of a body. The sensitive devices 8 are arranged on the machine 1 so that the monitoring area monitored by the aforementioned devices comprises at least partially the area dangerous for operators. In general, the entry of an object or a body through the monitoring area causes a variation in the signal that is perceived by the emitter element and that thus produces the actions signalling said presence. Preferably, the sensitive devices 8 are positioned side by side so as to be able to intercept an object or a body having dimensions at least equal to or greater than 2 cm, more preferably equal to or greater

than 4 cm. Such a size allows intercepting the passage of a hand because it has larger dimensions than the minimum required for mounting two adjacent pointed detection sensitive devices 8 (on reading along one direction and not on beam or surface reading). In this way, if the hand is intercepted because it is of a certain size, it is possible to place the shield at a very short distance from the excavation battery 6. In particular, defining a control circuit such that the chain of stop signals and controls of the manoeuvres has a minimum completion time since the interception of the body or of an object that is detected in the monitoring area, then it is possible to distribute said sensitive devices 8 at a minimum distance from the drilling battery, such that in the period of time elapsed between the interception and the actuation, the body or the object never come into contact with the excavation battery. Preferably, therefore, the sensitive devices 8 are positioned around the excavation battery 6, at the minimum distance therefrom; such a distance is linked at least to the response and intervention time of the safety system, so that the monitoring area guarded by the aforementioned sensitive devices 8 is able to cover the area around the drilling shaft 6, or to close on the guide antenna 3 in an area rear and around the shaft 6 in a front area and being able to intercept an object or a body of dimensions at least equal to or greater than 2 cm.

[0038] Indeed, in the case in which the aforementioned interception size of an object or of a body is equal to about 2 cm, then it would also be possible to intercept the passage of a finger of a hand and thus the monitoring area can be arranged ever closer to the excavation battery 6 and thus occupy as little space as possible.

[0039] On the other hand, the more the areas covered by the monitoring areas of the sensitive devices 8 are close or adjacent or even juxtaposed, the more complex and the greater the number of these devices to be installed will be. By arranging them radially around the excavation battery 6, at a minimum distance therefrom, the cylindrical surface that surrounds the battery will be the minimum possible and therefore both the number of sensitive devices and the coverage and protection degree required will be optimised consequently, with the minimum possible bulk.

[0040] The sensitive devices 8 can be adjusted to read some parameters and to intervene just when some conditions have been reached. For example, when the dimensions of the object crossing the reading beam has a greater size than a predetermined size. In this case, it is preferable to install the sensitive devices 8 at a minimum distance from the excavation battery 6, correlated at least to the intervention time for stopping the dangerous manoeuvre. Such sensitive devices 8 can be arranged side by side at a distance such as not to exceed the preset minimum reading distance (e.g. 4 cm or 2 cm) or they can be adjacent or, for greater safety, have monitoring areas at least partially juxtaposed.

[0041] In any case, the sensitive devices 8 are, advantageously, capable of detecting the presence of the operator in the dangerous area and of generating, following such detection, a corresponding control signal, preferably of the electric type. Such a control signal is adapted to at least stop the excavation battery 6, so as to preserve the safety of the operator. In detail, the control signal drives the actuators of the rotary head 5 to immediately stop at least the excavation battery 6 or alternatively to at least simultaneously stop both the rotation of said excavation battery 6 and the axial sliding of the rotary head 5 along the antenna 3.

[0042] In an embodiment of the present invention, the safety system comprises an electronic processing unit 10, for example an electronic control station or PLC. In this case, the control signal is sent to such an electronic processing unit 10 that is in turn configured to control at least the stop of the rotation of the excavation battery 6 following the reception of the aforementioned control signal.

[0043] Preferably, the electronic processing unit 10 can also be configured to block the sliding of the rotary head 5 and/or to control the emission of a sound or light signal that warns that a violation of the dangerous area has occurred.

[0044] Once the sensitive devices 8 have been activated, following the violation of the dangerous area, it is possible to reactivate the movement of the excavation battery 6 with the normal start-up procedure if it is wished to continue drilling. Such a procedure provides that the sensitive devices 8 are no longer triggered, that they have been reset, i.e. that the sensitive devices 8 are no longer detecting any object and that the reset of the situation is permitted for example through the intentional actuation of a reset button, that the normal operating mode is selected through a proper selector and that the start-up control is actuated.

[0045] If, on the other hand, it is wished to feed or dismount the drilling shafts 6 while the sensitive devices are triggered, a limited operating mode is enabled, through a proper dedicated mode selector (not illustrated). In such a limited operating mode all of the manoeuvres are properly slowed down up to values such as to eliminate the danger and allow the inspection of the parts or the execution of manual interventions. In order to leave the limited operating mode and go back to the normal operating mode, i.e. the work mode, it is necessary not to trigger the sensitive devices any longer and that they have been reset, that the normal operating mode has been selected through a proper selector and that the start-up control is actuated.

[0046] Preferably, the sensitive devices 8 are arranged so as to monitor a monitoring area that is close to the guide antenna 3 between the clamps 7 and the rotary head 5. Preferably, the monitoring area extends above the upper clamp, starting from the clamp itself up to a height of at least 2.5 m from the ground. In this case, the signal emitters of the sensitive devices 8 can be fixed to the guide antenna 3 at a height preferably greater than 2.5 m, whereas the corresponding receivers or reflector

components can be fixed on to the clamps 7 or on to the antenna 3 at the clamps 7; alternatively, the signal emitters can be fixed to the guide antenna 3 at the clamps 7 and the corresponding receivers or reflector components can be fixed to the guide antenna 3 at a height preferably greater than 2.5 m. Emitters and receivers or reflector components will be positioned opposite one another close to the clamps 7 and above at the top of the mast 3.

[0047] In an alternative embodiment of the present invention the sensitive devices 8 are installed on the machine 1 so that the sensitive area varies with the position of the rotary head 5 on the antenna 3. In this case, the signal emitters of the sensitive devices 8 are installed on the rotary head 5 and the corresponding receivers or reflector components are installed on the clamps 7 or on the antenna 3 at the clamps 7; alternatively, the signal emitters are fixed on to the clamps 7 or on the antenna 3 at the clamps 7 and the corresponding receivers or reflector components are fixed to the rotary head 5.

[0048] In this way, by fixing the sensitive devices 8 at a minimum distance from the excavation battery 6 it is possible to reduce the extension of the monitoring area and thus allow limiting as much as possible the bulk and bringing the antenna 3 close to walls or obstacles present on the building site. The rotary head, having to slide along the guide antenna 3, indeed, determines the minimum useful distance at which to position the machine 1 with respect to a wall or a vertical obstacle; therefore, if the sensitive devices 8 are arranged around the periphery of the rotary head 5 without projecting beyond it or limiting as much as possible said external projection, it is possible to generate an effective and safe protection having limited bulk. Moreover, the rotary head 5 is characterised by hydraulic and electric supplies to control the rotation and control some functions (like for example rotation, temperature, proximity sensors by inversion of the rotation movement), therefore the electrical supply of the emitting part can be easily installed following the pre-existing pipes and the guiding cable-winding for the axial movements along the guide antenna 3. Preferably, therefore, the emitters and the corresponding receivers or reflector components of the sensitive devices 8 are mounted opposite one another on the drilling machine 1, and in particular will be installed at one end on the rotary 3 and at the other end close to the clamps 7.

[0049] In a further alternative embodiment of the present invention, the signal emitters and the corresponding receivers or reflector components of the sensitive devices 8 are fixed to the guide antenna 3 in opposite positions, for example the emitters in the upper part of the guide antenna 3 and the receivers in the lower part of the guide antenna 3, in order to cover longitudinally the greatest possible length of the guide antenna 3.

[0050] In order to avoid the sensitive devices 8 being triggered by the projection of objects coming from the excavation being carried out, the safety system according to the present invention also comprises a shield 9 that is couplable with the machine 1 so as to extend in a substantially radial direction around the excavation battery 6 and indicatively in a direction perpendicular with respect to the front plane of the antenna 3 so as to define an upper area of the antenna 3, where the sensitive devices 8 are intended to be applied, and a lower area of the antenna 3 that is close to the mouth of the excavation.

[0051] The debris during the work steps tend to be projected towards the shield 9 due to the rotation and advancing energy of the excavation battery 6 or due to the injection pressure of the excavation fluids that rise from the hole transporting the debris, especially in tubed drilling technology, down the hole hammer with use of compressed air and jet grouting.

[0052] Advantageously, the shield 9 is shaped in such a way as to stop the rise of the material projected from the lower area to the upper area. In detail, the shield 9 is arranged to convey the excavation flow that comes out of the hole, the possible debris or piles, the water, the polymers or the drilling muds, directing them laterally or making them fall close to the clamps 7 preventing them from proceeding along their run upwards, hitting the area where the sensitive devices 8 are installed.

[0053] Preferably, the shield 9 is concave with the concavity facing the lower area.

[0054] Preferably, the shield 9 is fixed to the mast 3 or to the clamps 7 above them at a height preferably not greater than 200 millimetres with respect to the upper surface of the clamps 7. The interspace generated between the shield 9 and the clamps 7 acts as a channel in which the debris will be conveyed, in this way avoiding hitting the area above.

[0055] In this case, the signal emitters and the receivers of the sensitive devices 8 can be arranged so that the monitoring area is delimited by the shield 9 instead of the clamps 7.

[0056] Preferably, the shield 9 extends starting from the front and/or lateral surfaces of the guide antenna 3 in a direction perpendicular to the axis of the antenna 3 itself in order to cover at least the area close to the clamps or the dangerous area.

[0057] More preferably, the shield 9 extends so as to protect the monitoring area of the sensitive devices 8 like for example that indicated with a broken line in figure 1. In particular, the extension of the shield 9 and its shape define the dangerous area into which access is forbidden to any person during the steps of excavation and in particular of rotation of the tool, especially at maximum speed. The shield could extend radially to define a second boundary in which second sensitive devices could monitor a surface outer than the previous one, thus warning of the entry into a dangerous, but not yet forbidden area, of objects or bodies. Advantageously, the upper part of the shield 9, not exposed to dirt can be used to fix the sensitive devices 8, or, alternatively, for some types of signal, can be an integral part of the sensitive devices 8, acting itself as reflector component in order to generate the return of the signal to the emitter and thus determine the monitoring area.

[0058] In a first embodiment of the present invention the shield 9 can be flat and comprises a sheet of steel or of plastic or of rubber with a low thickness, which can vary from a few millimeters to a few centimetres as a function of the material of which it is made, so as to result particularly light. The shield 9 is fixed to the antenna or alternatively can be fixed to the body of the clamps 7. Such attachments are preferably of the removable type, such as bolts, in order to allow quick and easy replacement of the shield 9 in case of damage. The shield 9, at the excavation axis, has an opening 15 sufficient to allow the passage of the drilling shafts and at the same time sufficiently adherent to such shafts in order to prevent the passage of debris towards the area above the shield 9. Such an opening 15 can be adjustable or modified through interchangeable adapters in order to adapt to the different diameters of the shafts or to the different types of tool. Preferably, in order to block the interspace between the shaft and the shield 9 guide and/or holding means 13 can be provided, which are applied to the internal surface of the opening 15 of the shield 9.

[0059] In a particular embodiment of the present invention, the shield 9 can be made in a plurality of parts. Preferably, the shield 9 can comprise two half-shields arranged symmetrically with respect to the excavation battery 6 and coupled together in a selectively releasable manner; in this way, it is possible to decouple the half-shields from one another when the machine is inactive in order to allow easy cleaning of the shield itself and of the area below that is subject to the fall of debris coming from the shield.

[0060] In the particular embodiment of the present invention illustrated in figure 3 the shield 9 can be connected to the antenna 3, for example by means of jacks 11, so as to slide axially with respect to it and to further be locked at different heights and in such a way allow effective positioning or leave space for cleaning and maintenance to the clamps (also modulating the opening left for the passage of excavation debris).

[0061] In the particular embodiment of the present invention illustrated in figure 2 the shield 9 can have a concave shape towards the base of the antenna, for example like a cap or funnel. The concave shape allows conveying the debris towards the base of the antenna and limiting the area into which it will fall.

[0062] Furthermore, the shield 9 can advantageously be equipped with borders or lateral bulkheads in order to contain the drainage of the drilling fluids in an area surrounding the clamps 7.

[0063] In a variant in fig.4, the shield 9 has, on the lower surface, a plurality of spraying nozzles 12 with ducts that are fed with water. Such spraying nozzles 12 can reduce the drilling dusts and make the work environment cleaner especially for the use of sensitive devices 8 of the optical type. In a totally analogous manner, it is possible to connect proper feeding mouths to an air suction system in order to reduce the dusts in the area adjacent to the hole.

[0064] In the case in which the at least one drilling segment or shaft is helical 6B, as illustrated in figure 5, the shield 9 advantageously comprises cleaning means 14 of the helix such as to make the material contained among the turns fall and prevent it from falling and crossing the monitoring area defined by the sensitive devices 8 once it has risen up.

[0065] In particular, the cleaning means 14 can be stationary, like for example blades or shares and in this case the helix must rotate during the extraction from the hole, or it can be stationary and flexible, like for example brushes or motorised elements rotating about the helix 6B and in this case the helix may not rotate during the extraction from the hole. The cleaning means 14 could also be arranged in an independent structure, preferably fixed, which lies between the clamps at the bottom and the shield at the top.

[0066] From the description that has been made the characteristics of the safety system and of the excavation machine object of the present invention are clear, just as the relative advantages.

[0067] Indeed, the safety system described minimises the possibility of undesired stops of the excavation machine in the absence of dangerous conditions, whilst at the same time still maintaining the maximum reliability in detecting conditions of actual danger, i.e. the presence of an operator or other personnel in the dangerous area. In particular, such an advantage is achieved through the presence of the shield that separates the lower part of the guide antenna, close to the excavation area, from the upper part intended for the operation of the sensitive devices.

[0068] Moreover, such a shield is able to stop the material projected from the excavation area towards the area of the sensitive devices during the work steps of the machine. In this way, the triggering of the sensitive devices can only be caused by the interception of an operator or of an obstacle intercepting the signal or the barrier emitted by the sensitive devices.

[0069] The protection provided by the shield also allows keeping the sensitive devices located above the shield 9 clean and efficient.

[0070] The use of sensitive devices is advantageous since they have minimum impact on the weight; in particular, such a solution is much lighter than the barriers used in the prior art.

[0071] In the same way, the shield 9 also has a limited weight. This translates into greater stability, into better performance and into greater manoeuvrability of the machine.

[0072] Moreover, both the sensitive devices and the shield do not increase the bulk of the machine, ensuring excellent accessibility of the machine to areas close to walls or edges.

[0073] The shield, being in a lowered position, preferably no more than 200 millimetres above the clamps, does not hinder the loading of the shafts because it does not increase the loading height with respect to the ground. Moreover, such positioning does not reduce the actual

stroke of the rotary head since the shield is in an area not reachable by the rotary head itself.

[0074] The safety system, thanks to the use of the sensitive devices, maintains its efficiency also during the work steps carried out with antenna inclined frontally or laterally and also when it is arranged horizontally. In all these configurations, the devices have a monitoring area that delimits the dangerous area around the guide antenna and in particular such a monitoring area can extend longitudinally to the mast for its entire length.

[0075] The area that surrounds the shafts remains free, i.e. without solid shields or protective cages. Consequently, when the machine is inactive, and the sensitive devices are turned off, the area of the shafts remains easily accessible for inspection and maintenance. Differently, in known systems that adopt fixed or movable barriers, they represent an obstacle to inspection and maintenance even when the machine is inactive.

[0076] Finally, it is clear that the safety system and the excavation machine thus conceived can undergo numerous modifications and variants, all of which are covered by the invention; moreover, all of the details can be replaced with technically equivalent elements. In practice, the materials used, as well as the sizes, can be whatever according to the technical requirements.

Claims

1. Safety system for controlling a dangerous area of an excavation machine (1) provided with a guide antenna (3), a rotary head (5) coupled in a sliding manner on said guide antenna (3) and arranged for supporting and moving an excavation battery (6), said safety system comprising:

- a shield (9) coupable to said machine (1) so as to extend in a substantially radial direction around said excavation battery (6) defining an upper area of said guide antenna (3) and a lower area of said guide antenna (3) where the excavation occurs,

said safety system being **characterized in that** said shield (9) is shaped so as to stop the raising of the material projected from said lower area towards said upper area, said safety system comprising a plurality of sensitive devices (8) intended to be positioned in said upper area and configured for generating a monitoring area, for detecting the presence and/or the passage of a body in said monitoring area and for generating, following such detection, a corresponding control signal adapted to at least stop the rotation of said excavation battery (6), said sensitive devices (8) being arranged on said machine (1) so that said monitoring area at least partially comprises said dangerous area.

2. Safety system according to claim 1 wherein said shield (9) is concave with the concavity facing said lower area.

3. Safety system according to claim 1 or 2 wherein said shield (9) is provided with a plurality of water spraying nozzles (12) for reducing the drilling dusts.

4. Safety system according to one of the preceding claims wherein said shield (9) is provided with borders or lateral bulkheads to keep the drainage of the drilling fluids in said lower area.

5. Safety system according to one of the preceding claims wherein said shield (9) is made of a plurality of parts.

6. Safety system according to claim 5 wherein said shield (9) comprises two half-shields arranged symmetrically with respect to said excavation battery (6) and coupled to each other in a selectively releasable manner.

7. Safety system according to one of the preceding claims wherein said shield (9) is connectable to said antenna guide (3) so as to be axially slidable with respect to said antenna (3) and to be subsequently lockable at different heights.

8. Safety system according to one of the preceding claims wherein said control signal is capable of guiding said rotary head (5) to at least simultaneously stop the rotation of said excavation battery (6) and the axial sliding of said rotary head (5) along said guide antenna (3).

9. Safety system according to one of the preceding claims comprising an electronic processing unit configured for controlling at least the rotary stop of said excavation battery (6).

10. Safety system according to claim 9 wherein said electronic processing unit is also configured for blocking the sliding of said rotary head (5) along said guide antenna (3), and/or for controlling the emission of a sound or light signal.

11. Excavation machine (1) comprising:

- a guide antenna (3);
- a rotary head (5) coupled in a sliding manner on said guide antenna (3);
- an excavation battery (6) coupled to said rotary head (5), said rotary head (5) being arranged to support and move said excavation battery (6);
- a safety system according to one of the preceding claims.

12. Excavation machine (1) according to claim 11 wherein said sensitive devices (8) are arranged side by side so as to be able to intercept an object or a body with dimensions at least equal to or greater than 2 cm.

13. Excavation machine (1) according to claim 11 or 12 wherein said shield (9) is fixed to said antenna (3).

14. Excavation machine (1) according to one of claims 11 to 13 wherein said guide antenna (3) is provided with at least one pair of clamps (7) and said shield (9) is fixed to said at least one pair of clamps (7) above them.

15. Excavation machine (1) according to one of claims 11 to 13 wherein said sensitive devices (8) are fixed to said guide antenna (3).

16. Excavation machine (1) according to one of claims 11 to 15 wherein said sensitive devices (8) are installed on said machine (1) so that the extension of said monitoring area varies according to the position of said rotary head (5) with respect to said antenna (3).

17. Excavation machine (1) according to claim 16 wherein each of said sensitive devices (8) comprises a signal emitter and a corresponding receiver or reflector component, which are mounted opposite each other at an end on the rotary head (5) and at the other end close to the clamps (7).

18. Excavation machine (1) according to any of the preceding claims wherein said shield (9) is an integral part of the sensitive devices (8), operating as a reflector component.

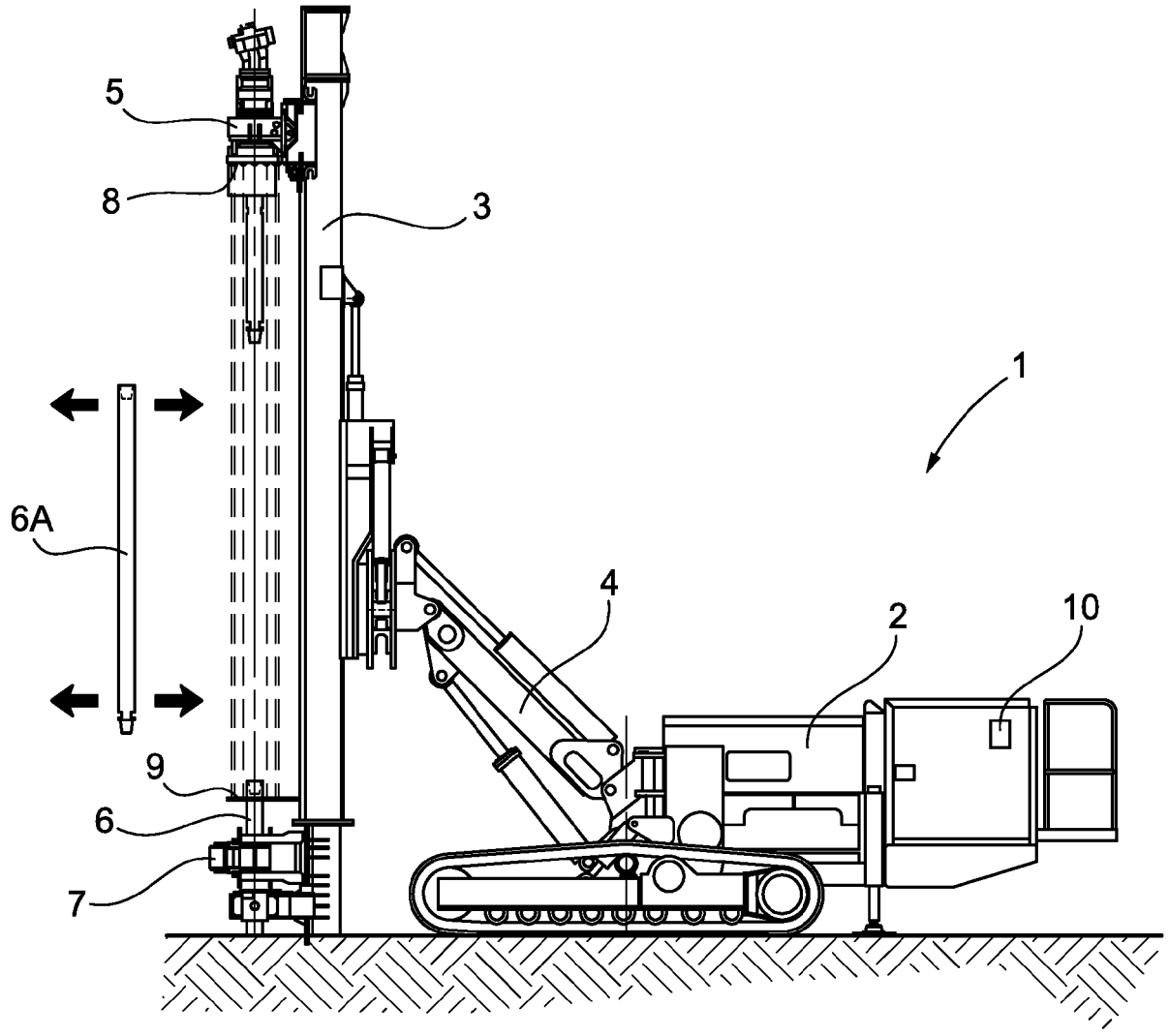

Fig. 1

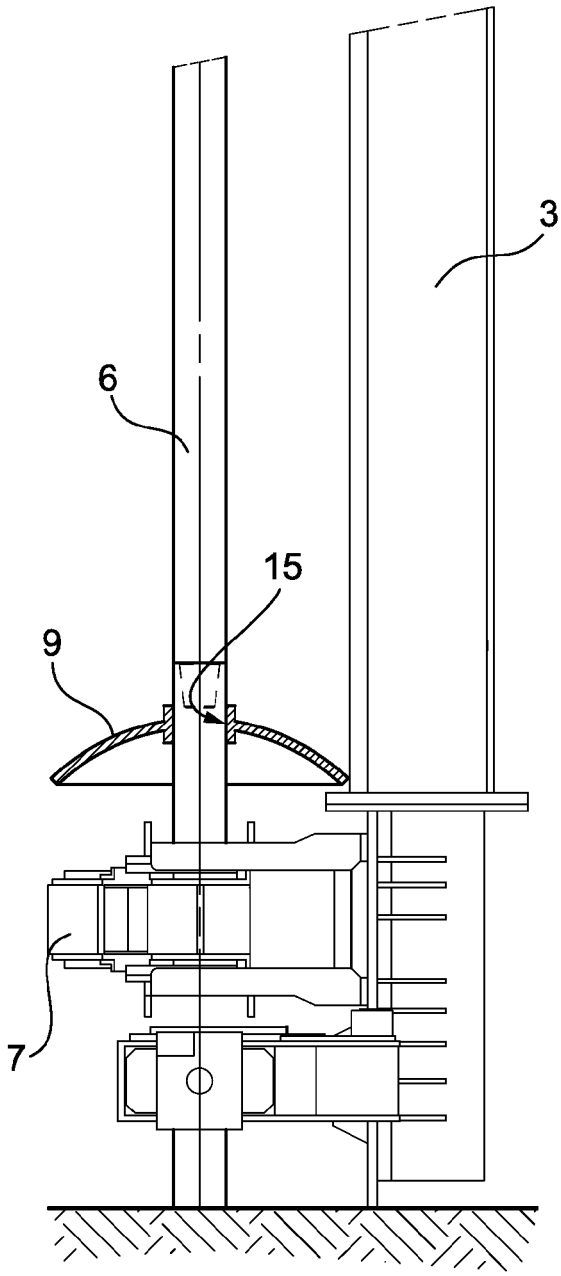

Fig. 2a

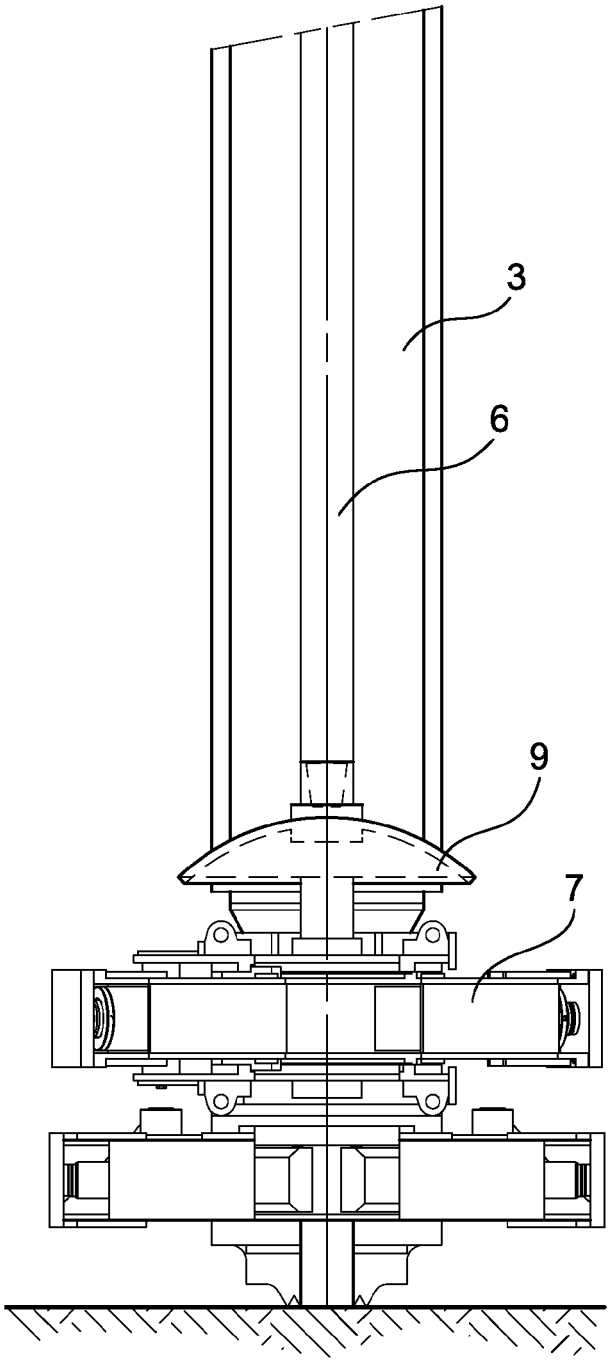

Fig. 2b

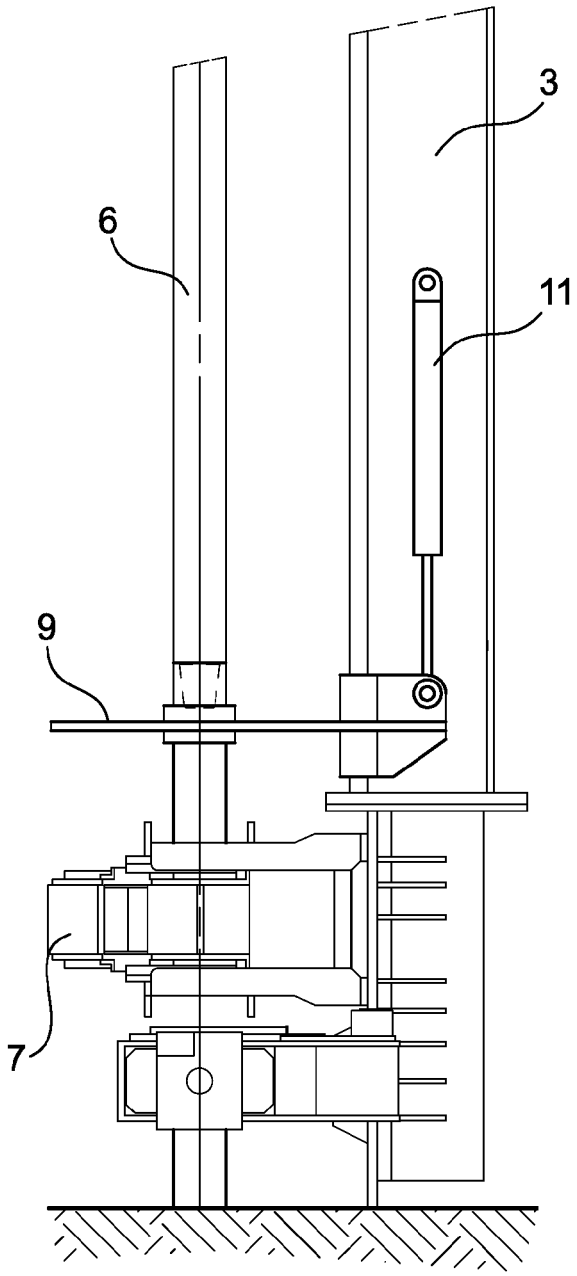

Fig. 3a

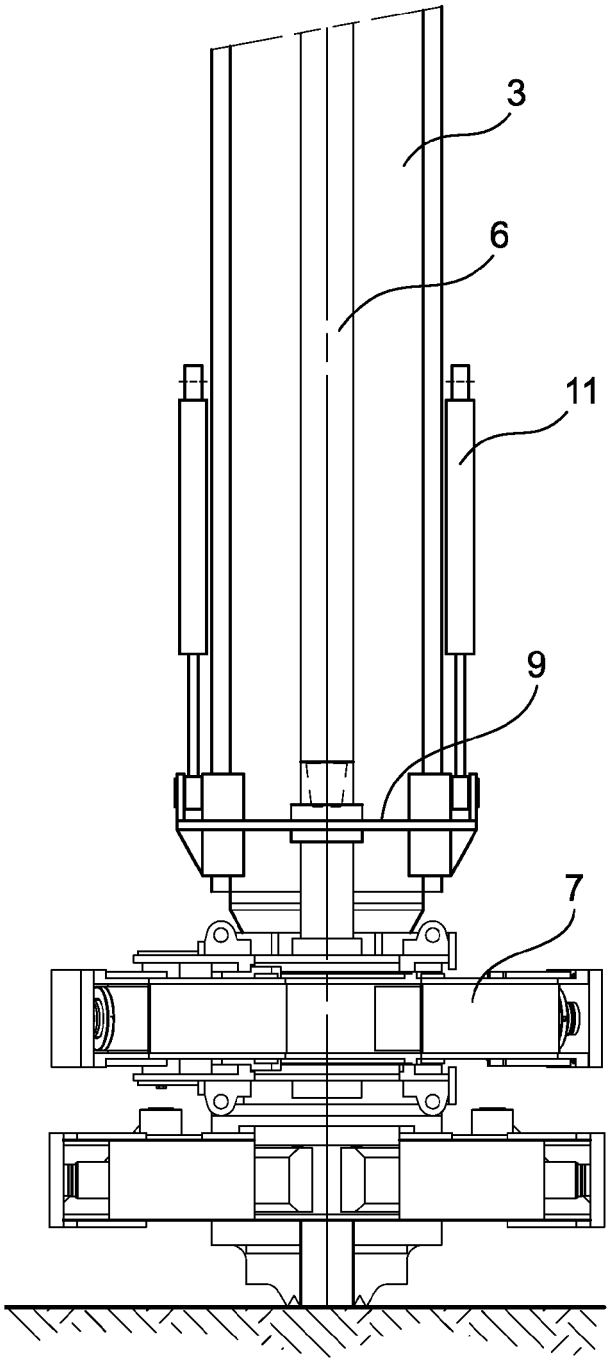

Fig. 3b

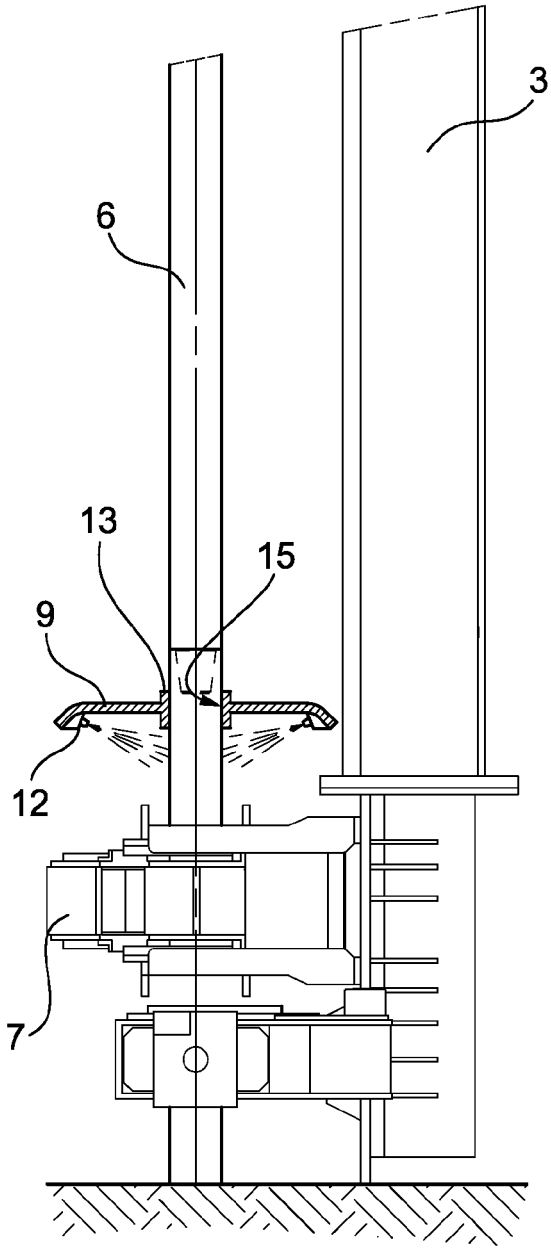

Fig. 4a

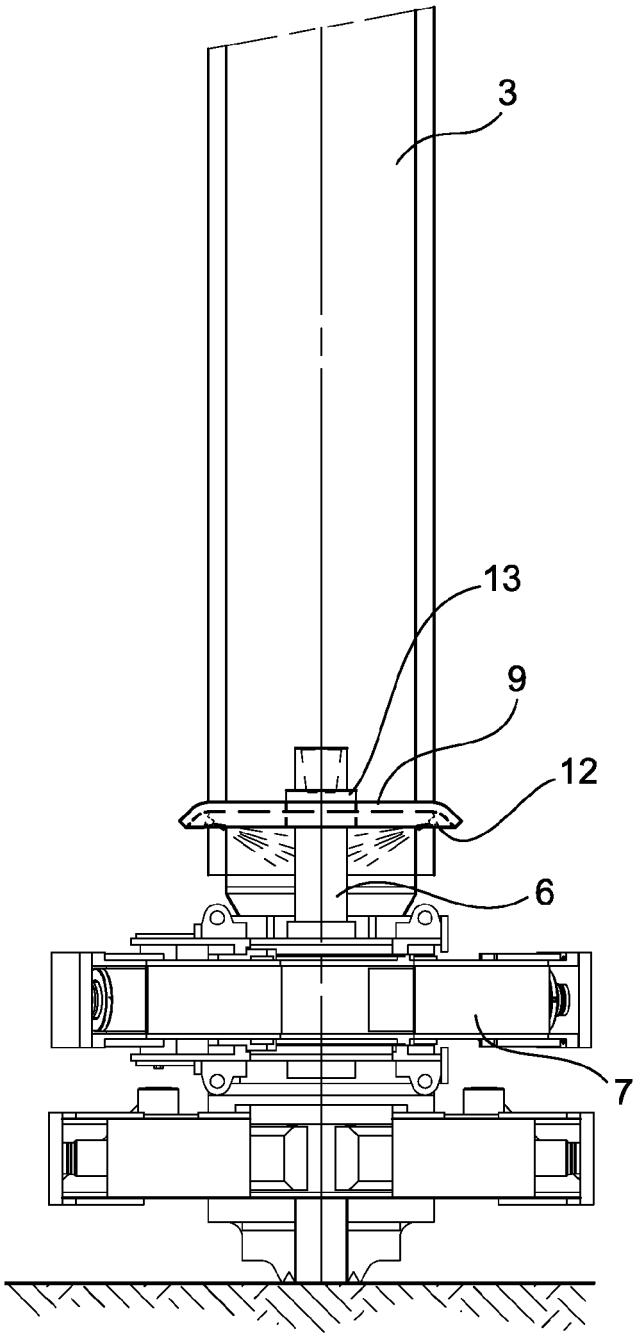

Fig. 4b

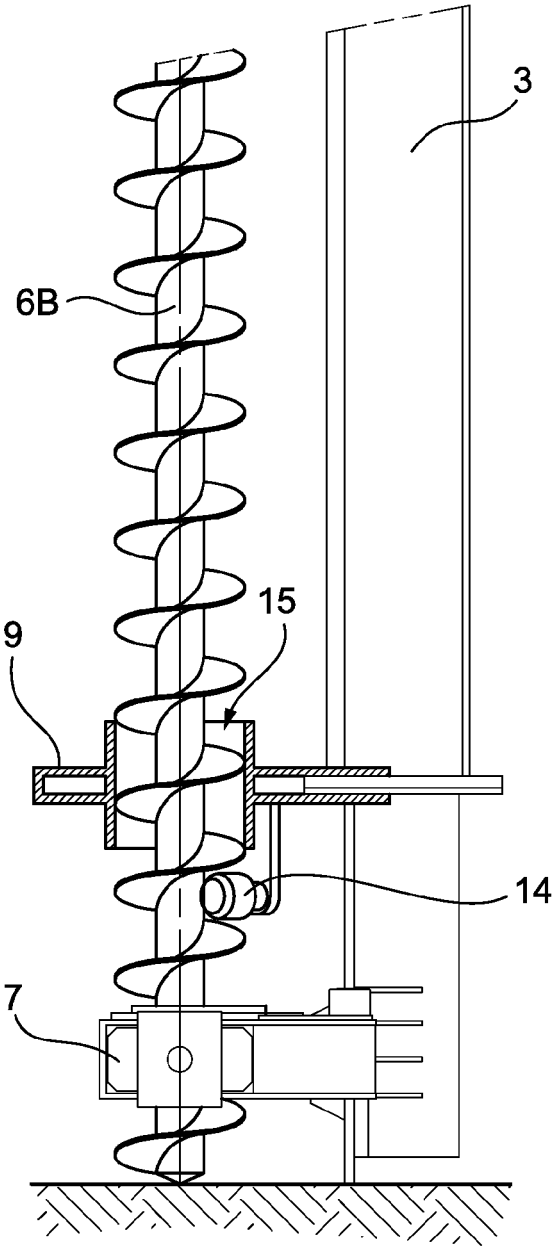

Fig. 5a

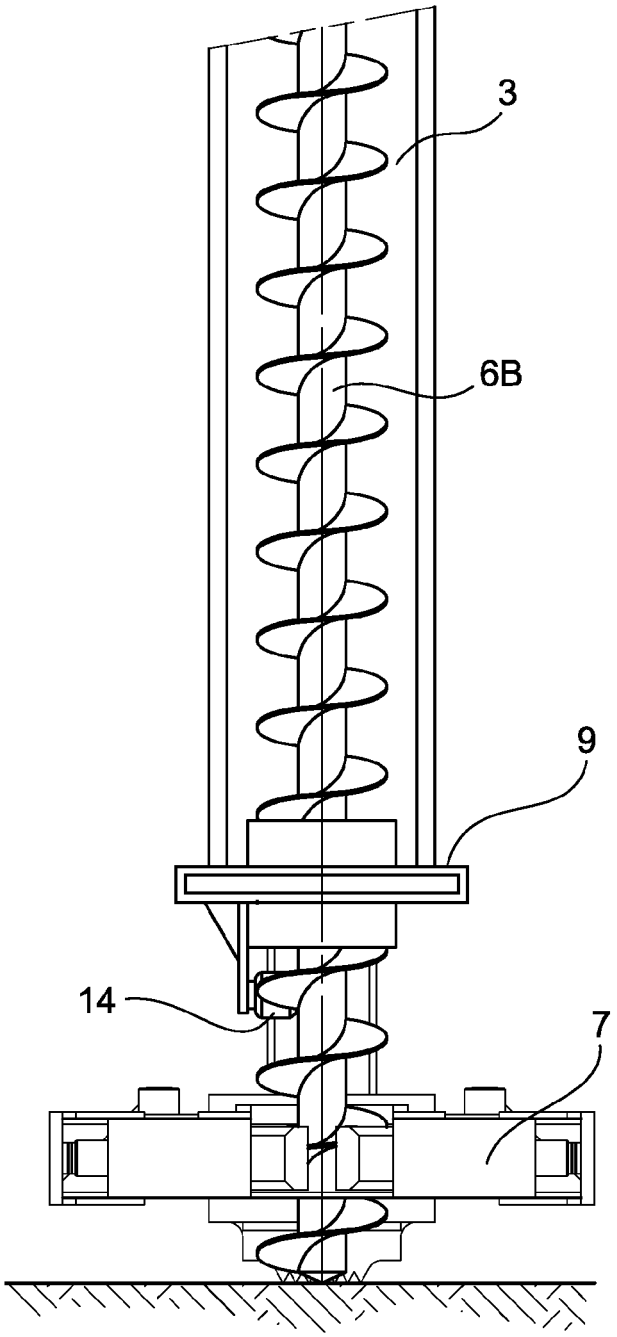

Fig. 5b

Europäisches Patentamt
European Patent Office
Office européen des brevets

EUROPEAN SEARCH REPORT

Application Number
EP 15 16 9672

DOCUMENTS CONSIDERED TO BE RELEVANT

Category	Citation of document with indication, where appropriate, of relevant passages	Relevant to claim	CLASSIFICATION OF THE APPLICATION (IPC)
A	WO 2011/051564 A1 (SANDVIK MINING & CONSTR OY [FI]; LUOMA LASSI [FI]) 5 May 2011 (2011-05-05) * the whole document *	1-18	INV. E21B41/00 E21B7/02 E21B44/00 E21B21/015
A	US 4 282 940 A (SALISBURY WINFIELD W ET AL) 11 August 1981 (1981-08-11) * the whole document *	1-18	
A	US 3 848 686 A (ERICSSON B ET AL) 19 November 1974 (1974-11-19) * the whole document *	1-18	
A	EP 2 672 014 A2 (SOILMEC SPA [IT]) 11 December 2013 (2013-12-11) * the whole document *	1-18	
			TECHNICAL FIELDS SEARCHED (IPC) E21B

The present search report has been drawn up for all claims

Place of search	Date of completion of the search	Examiner
Munich	28 September 2015	Manolache, Iustin

CATEGORY OF CITED DOCUMENTS

X : particularly relevant if taken alone
Y : particularly relevant if combined with another document of the same category
A : technological background
O : non-written disclosure
P : intermediate document

T : theory or principle underlying the invention
E : earlier patent document, but published on, or after the filing date
D : document cited in the application
L : document cited for other reasons

& : member of the same patent family, corresponding document

EPO FORM 1503 03.82 (P04C01)

ANNEX TO THE EUROPEAN SEARCH REPORT ON EUROPEAN PATENT APPLICATION NO. EP 15 16 9672

This annex lists the patent family members relating to the patent documents cited in the above-mentioned European search report. The members are as contained in the European Patent Office EDP file on
The European Patent Office is in no way liable for these particulars which are merely given for the purpose of information.

28-09-2015

Patent document cited in search report	Publication date	Patent family member(s)	Publication date
WO 2011051564 A1	05-05-2011	AU 2010311239 A1	21-06-2012
		CN 102597411 A	18-07-2012
		EP 2494137 A1	05-09-2012
		FI 20096109 A	29-04-2011
		JP 2013509511 A	14-03-2013
		US 2012205190 A1	16-08-2012
		WO 2011051564 A1	05-05-2011
US 4282940 A	11-08-1981	NONE	
US 3848686 A	19-11-1974	DE 2330128 A1	03-01-1974
		JP S4950750 A	17-05-1974
		SE 379823 B	20-10-1975
		US 3848686 A	19-11-1974
EP 2672014 A2	11-12-2013	EP 2672014 A2	11-12-2013
		US 2014151078 A1	05-06-2014

EPO FORM P0459

For more details about this annex : see Official Journal of the European Patent Office, No. 12/82

REFERENCES CITED IN THE DESCRIPTION

This list of references cited by the applicant is for the reader's convenience only. It does not form part of the European patent document. Even though great care has been taken in compiling the references, errors or omissions cannot be excluded and the EPO disclaims all liability in this regard.

Patent documents cited in the description

- WO 2011051564 A **[0007]**