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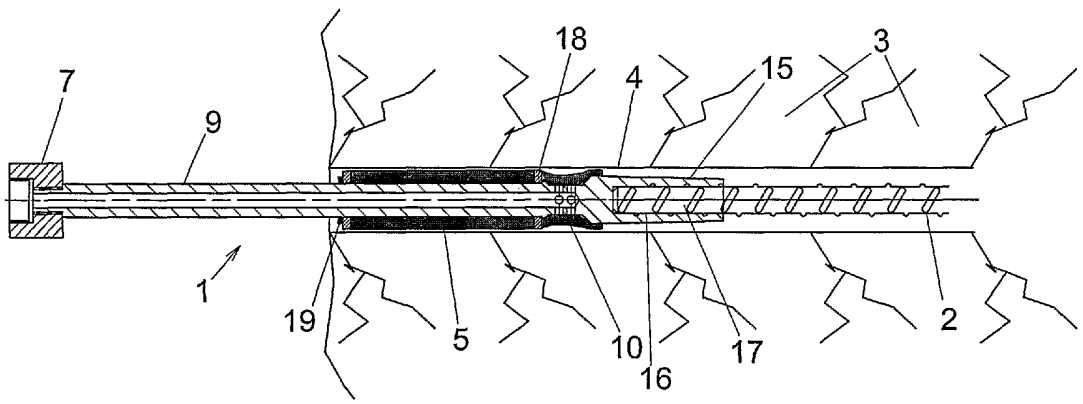
(54) Title: ARRANGEMENT FOR INJECTING AND AFFIXING A REINFORCING OR ANCHORING ELEMENT IN A ROCK WALL



(57) Abstract: The present invention relates to an arrangement and to a method for injecting and affixing a reinforcing and/or anchoring element in a rock wall. The arrangement includes means (15; 65) for connection to a reinforcing and/or anchoring element (2; 62), an injection pipe (9) which is connected to the coupling means at a front end facing inwardly in the hole and which includes means (7) for connection to means for supplying injection medium (8). The arrangement also includes a check valve (10) for co-action with the injection medium, and an expandable seal (10; 50; 60). The arrangement is designed as a separate unit that can be loosened from the reinforcing and/or anchoring element upon completion of the injection phase. The method comprises corresponding process steps.

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For two-letter codes and other abbreviations, refer to the "Guidance Notes on Codes and Abbreviations" appearing at the beginning of each regular issue of the PCT Gazette.

Arrangement for injecting and affixing a reinforcing or anchoring element in a rock wall.

Field of the invention

The present invention relates to an arrangement and a method for affixing reinforcing and/or anchoring elements in rock walls in accordance with the preamble of claim 1 and in accordance with claim 13.

Background of the invention

Work on and in rock walls often results in problems relating to crack formations, the danger of rock slides or rock slips and other hazards that make it necessary to reinforce the rock wall. For example, such problems may occur in the building of tunnels or rock cavities, and may also apply to open - air rock walls in the construction of roads, highways and the like. In such cases reinforcement is most often achieved with the aid of different methods in which reinforcement elements, normally in the form of reinforcing rods or reinforcement rounds or the like anchored in holes drilled in the rock wall. So-called rockbolts and roof bolts are examples of reinforcing and/or anchoring elements.

A well known and simple method of affixing reinforcement elements in a rock wall involves firstly the injection of cement or like material into a hole in the rock wall. This hole may be an already existing hole in the rock wall, although the hole will be a separately pre-drilled hole in the majority of cases. A reinforcing element is then inserted into the cement, whereafter the entire cement package is allowed to harden. As the cement hardens it will shrink somewhat and because there is no other form of anchorage in the rock wall than that afforded by the adhesion of the cement to the rock face, there is often the danger that the entire cement-"plug", including the reinforcement element, will loosen and at times even fall out of the hole.

Another problem experienced when working with and in rock walls is that moisture and water may obtain ingress through cracks for instance, which often results in the need to seal such cracks. When holes are drilled for the reinforcement of rock walls as described above, leakages also often occur as a result of puncturing the natural screen that was present prior to drilling. A

punctured screen is often sealed by injecting some kind of sealing agent into the drilled holes. One example of such a sealing agent is cement grout or concrete injected into the hole. However, these sealants are not able to penetrate out into the actual cracks and consequently the leakage problems remain in many instances. Another method of sealing the rock is to cover the entire inner surface of the rock wall with concrete or some other suitable material for instance.

Neither is it permitted to secure reinforcing bolts in water-conducting holes in several instances, but that it must first be ensured that the hole is dry before securing such bolts.

The insertion of a sealing agent or filler in a rock-wall hole is often carried out with the aid of a so-called packer. A packer typically includes a tubular part fitted to the end of a tubular drill bit or to a conduit for delivering some type of sealant, and an expandable cuff, made for instance of a rubber-like material, is disposed on the tubular part. When the cuff is caused to expand, the packer will be held firmly to the inner surface of the hole by friction, and therewith seal against the walls of the hole. The sealant subsequently injected into the hole is thus unable to run out while still in a liquid state, provided that the packer remains seated in the hole.

Prior publication WO 99/56001 teaches an arrangement for reinforcing and sealing a rock wall, said arrangement comprising a reinforcing rod that is connected to an injection element that includes an injection pipe and a check valve. The reinforcement rod is permanently connected to the check valve and is inserted into a pre-drilled hole together with the injection element. The rod is anchored in the hole and an expandable seal ensures that injected material is unable to run back out of the hole and the injection material is injected into the hole via the injection pipe and a check valve, wherein the check valve includes a cuff that prevents injection material being pressed back via the valve. The injection phase is effected at an overpressure, wherewith injection material shall also be capable of penetrating any possible cracks that open into the hole. Cement and concrete are mentioned as examples of injection material. The seal is expanded by tightening a nut disposed beneath the seal and therewith compress the seal, via a washer or like device. The nut and the washer can be removed upon completion of the injection phase and after the material has hardened, wherewith the seal is allowed to return to its non-expanded state, whereafter the seal may

also be removed. Remaining parts of the arrangement are left permanently in the drilled hole on the other hand. One drawback with this known arrangement is that it cannot be re-used and is therefore expensive. Another drawback is that there is always a risk of corrosion attack in the space that remains in the lower part of the hole after having removed the seal, nut and washer, despite subsequently filling the space with a filling material, due to the fact that parts of the injection device still remain in the hole.

In such cases there is also a need of fixating in the rock anchoring devices which enable other devices to be secured in or to the rock wall. This may apply, for instance, to affixing rockbolts, affixing reinforcement nets in the case of injection processes, affixing a protective net to prevent loose pieces of rock or stones from falling down onto a road surface or somewhere else, providing a suspension point for different devices and elements used in mining and tunnelling practices, affixing ventilation equipment comprising fans, blowers and ducts, channels/drums for other purposes, lighting, etc.

Summary of the invention

The aim of the present invention is to provide an arrangement and a method which will resolve these problems and satisfy the needs mentioned above. This aim is achieved by means of an arrangement that has the novel features set forth in the characterising clause of the accompanying claim 1, and by means of a method that has the characterising features set forth in claim 13.

Thus, the inventive arrangement comprises a coupling which is connected to a reinforcing and/or anchoring element, and an injection pipe which is connected to the coupling means at a front end that faces inwardly in the hole and which is also provided with connecting means for connection to an injection medium supply means, wherein the arrangement also includes an injection medium check valve and an expandable seal, and wherein the invention is characterized in that the arrangement has the form of a separate unit that can be disengaged from the reinforcing and/or the anchoring element upon completion of the injection phase.

The advantage afforded by this arrangement is that solely the end of the reinforcing and/or the anchoring element is exposed within the hole, and no other parts remain. An additional advantage is that it is much simpler to seal-off the

remaining hole and the end of the reinforcing and/or the anchoring element than is possible in the case of the earlier known technique, by injecting some type of filler into the hole subsequent to completion of the injection phase. This greatly reduces the risk of corrosion attack. Alternatively, it may be elected not to fill the remaining part of the hole with filler and, instead, obtain the advantage of being able to use the free end of the reinforcing/anchoring element in the hole as an anchorage and securing point for diverse equipment. Examples of such equipment have already been mentioned above.

Another advantage afforded by constructing the injection arrangement as a separate unit is that it can be removed from the hole upon completion of the injection phase so as to enable it to be re-used in a new hole, even repeatedly. The invention thus affords significant cost savings. A particularly beneficial embodiment of the invention thus enables the arrangement to be re-used.

According to another beneficial feature of the invention, the arrangement is characterized in that the coupling means has an internally threaded coupling end for connection with an externally threaded end of the reinforcing and/or anchoring element. The coupling means and the injection pipe comprise a single entity, which affords the advantage of greater mechanical strength than would otherwise be the case, eliminates the risk of these components being separated from each other after having been screwed together and the entire arrangement shall be unscrewed from the anchoring point, and enables the arrangement to be handled more practically from a general aspect. The coupling means is beneficially also designed so as to facilitate the release of the arrangement from the surrounded injected material upon completion of the material injection phase and subsequent to hardening of the material. This can be achieved by causing the coupling means, which is typically cylindrical, to taper conically to a slight extent in a direction inwardly in the hole, or to coat the outer surface of the coupling means with Teflon for instance, or with some readily elastic or resilient material. Other coupling means may, alternatively, be greased. A combination of these proposed alternatives is also feasible.

According to one feature of the arrangement, the seal has the form of a sleeve disposed around the injection pipe. The sleeve will then function beneficially as an inner seal defining wall, wherewith the seal is caused to expand

radially outwards between the outer wall of the injection pipe and the inside of the hole for sealing abutment with both outer wall and inner surface.

According to one variant, the seal has the form of a mechanically expandable sleeve.

According to another variant, the seal has the form of a sleeve that includes double walls and that can be expanded by injecting a pressurised medium into the sleeve between said walls. Consequently, the inventive arrangement also includes means for delivering pressurised medium to the seal.

According to a first embodiment, the check valve is disposed at the front end of the injection pipe. This embodiment is beneficial when the reinforcing and/or anchoring element is a solid rod and when the injection medium shall be pressed out into the hole behind the coupling means but in front of the seal.

According to a second embodiment, the arrangement is characterized in that the coupling means includes an axially extending and through-passing aperture and is designed to enable it to be coupled to a tubular element that forms said reinforcing and/or anchoring element; and is further characterized in that the check valve functions to regulate the supply of injection medium from the injection pipe via the aperture in the coupling means and through said tubular element and out at the front end thereof. The benefit afforded by this embodiment is that the injection medium can be fed out at a point much further into the hole, depending on the length of the tubular reinforcing and/or anchoring element, and there penetrate into the cracks etc. present in the rock wall.

A further benefit achieved by this embodiment is that the tubular element forming the reinforcing and/or anchoring element may consist of a drill rod that includes internal channels and also a drill bit for boring said holes, wherewith the check valve regulates the supply of injection medium from the injection pipe via the aperture in the coupling means, through said drill rod and out through the drill bit.

The inventive method of injecting and securing a reinforcing and/or anchoring element in a rock wall comprises the following method steps:

- inserting a reinforcing and/or anchoring element in a hole in the rock wall with said element coupled to an injection means which constitutes a separate entity or unit and includes means for coupling the injection means to a reinforcing and/or anchoring element, an injection pipe which is

connected to said coupling means at a front end facing inwardly in the hole and which is also provided with connecting means for connection to an injection medium supply means, wherein the arrangement also includes a check valve for co-action with the injection medium and an expandable seal;

- expanding the seal on the injection means so as to prevent injection medium injected into the hole from exiting from the hole during and after the medium injection phase;
- delivering injection medium to the hole via said injection arrangement and said check valve;
- terminating the injection phase and allowing the injection medium to harden;
- causing the expandable seal to return to its non-expanded state after termination of the injection phase and allowing the injection medium to harden at least partially; and
- removing the injection means as a unit.

This method affords the benefits that no part of the injection means will be left in the hole, therewith greatly reducing the risk of corrosion in the hole and also enables the injection means to be re-used as it is.

Another beneficial feature is that the hole is drilled with the aid of a drill rod provided with a drill bit where said drill rod later forms the reinforcing and/or anchoring element, and that drilling takes place when the injection means has already been coupled to the reinforcing and/or anchoring element. According to the inventive method, the injection phase can be carried out via a through-penetrating aperture in the coupling means and also via an internal channel in the drill rod and out into the hole via the drill bit fitted to the front end of the drill rod.

According to the inventive method, the injection medium is beneficially injected at an overpressure, wherewith the hole is first filled with injection medium which then penetrates into any cracks present in the surrounding rock, said injection means opening out into the hole so as to thereby seal the cracks. Among other things, this avoids the risk of the injected medium solely forming a plug in the hole without being anchored to the surrounding rock. As earlier mentioned, any plug that forms can easily loosen from the sides of the hole and therewith fall out

of the same. By overpressure is meant in this case a pressure of at least 1 bar and normally between 1 – 2 bar and up to 100 bar or even at a higher pressure if necessary. With regard to sealing the rock, the pressure applied must also be adapted to the nature of the rock into which the medium is injected. The rock is sometimes of a poor quality, i.e. very porous and perhaps also water-conducting, wherewith a high pressure is required in sealing the rock, in some instances up to several hundred bar. A high injection pressure eliminates the risk of pockets of air and water. The reinforcing element is also anchored more securely in the rock.

The magnitude of the pressure required will also depend on the extent of the rock covering above the area to be sealed, in other words on how much rock is located above this area, and will also depend on the static pressure exerted by the ground water. The ground water pressure will also be high in the case of rock that includes an open-air lake, therewith requiring the application of a high injection pressure.

Another beneficial feature afforded by the inventive method is that the injection means can be re-used for the injection and anchoring of a new reinforcing and/or anchoring element in the rock wall. This clearly constitutes an economic benefit in comparison with earlier known arrangements of the one-time-use only type.

Finally, a further beneficial feature afforded by the invention is that subsequent to removing the injection means the reinforcing and/or anchoring element will have a free end located within the hole sealed with the injection medium, this free end being available for the attachment of further equipment. This is of enormous benefit. Examples of equipment that can be secured with the aid of an anchoring element include ventilation systems in tunnel roofs, ventilation ducts, fans, blowers and lighting equipment. The anchoring element can also be used to hang-up other equipment used in tunnelling practices for instance. Further examples include devices for fastening reinforcing nets, protective nets against stone and rock slides, etc. The anchoring element can also be used solely for securing a device that pressurizes the rock as it is.

Brief description of the drawings

The present invention will now be described in more detail with reference to the exemplifying embodiments illustrated in the accompanying diagrammatic drawings, in which

Figure 1 is a diagrammatic sectioned side view of a first embodiment of an inventive arrangement that includes a first variant of the expandable seal with the seal shown in a non-expanded state;

Figure 2 is a diagrammatic side view corresponding to Figure 1, but showing the expandable seal in an expanded state;

Figure 3 is a diagrammatic sectioned side view of a second embodiment of an arrangement according to the present invention, showing a second variant of the expandable seal with the seal in a non-expanded state;

Figure 4 is a diagrammatic side view corresponding to Figure 3, but showing the expandable seal in an expanded state;

Figure 5:1-8 illustrates the method of using an arrangement according to the first embodiment;

Figure 6: 1-6 illustrates the method of using an arrangement according to the second embodiment;

Figure 7 is a diagrammatic sectioned side view of a third embodiment of an arrangement according to the present invention, with the expandable seal shown in a non-expanded state;

Figure 8 is a diagrammatic side view corresponding to Figure 7, but showing the expandable seal in an expanded state; and

Figure 9 is a diagrammatic sectioned side view illustrating an example of use in accordance with the inventive method.

Those components shown in the figures that are common to the various embodiments have been identified with the same reference signs.

Detailed description of the invention

Figures 1 and 2 illustrate a first embodiment of an arrangement 1 for injecting and securing a reinforcing element and/or anchoring element 2 in a rock wall 3, in accordance with the present invention. For the sake of simplicity the arrangement will be referred to solely as an injection means in the following text.

Correspondingly, the reinforcing and/or anchoring element 2 will be referred to solely as the reinforcing element in the following text. This should in no way be understood as limiting the scope of the invention. The reinforcing and/or anchoring element 2 may also consist of solid iron material or a hollow tube.

Figures 1 and 2 show a first embodiment of the injection means 1 coupled to the reinforcing element 2, wherewith the mutually coupled members are together inserted into a hole 4 in a rock wall 3. The injection means constitutes a separate unit. The illustrated first embodiment of the injection means 1 includes a first variant of a packer-type expandable seal, namely a mechanically expandable seal 5. The injection means 1 also includes means 7 for connection to a means (not shown) for supplying an injection medium 8. This supply means preferably includes a pump, which enables the injection medium to be supplied at an overpressure. A suitable injection medium is a cement grout or a chemical liquid. The connection means 7 is provided at the end of an injection pipe 9 remote from the hole, this end also being called the outer end. A check valve 10 is provided in connection with the front end of the injection pipe line, i.e. the end proximal to the hole 4. This check valve may be of a known kind, e.g. of the kind known from prior publication WO 99/56001. The check valve 10 shall, in any case, be able to withstand the pressure at which the injection medium is injected, so as to ensure that the injection medium will not flow back out through the valve. The injection means 1 also includes coupling means 15 on the front end of the injection pipe. This coupling means has an internal thread 16 and is screwed to an externally threaded end 17 of the reinforcing element 2. The reinforcing element 2 is thus of a typical kind provided with an external thread.

The hole 4 in the rock wall 3 may be an existing hole or a hole that was made particularly for the purpose concerned.

Figure 1 shows the injection means 1 and the reinforcing element 2 when they have just been inserted into the hole 4, prior to expansion of the seal 5. This figure also corresponds to Figure 5:2.

Figure 2 shows the injection means 1 when the seal 5 has been caused to expand and therewith seal against the inner wall of the hole 4. As will be seen, the seal 5 of this embodiment has the form of an expandable sleeve disposed around the injection pipe 9. The seal 5 is made of an elastic, resilient, springy material or some other yieldable material, such as rubber, so as to enable its shape to be

changed. The seal is caused to expand mechanically with the aid of a known, separate clamping tool 20, which is shown in Figure 5:3. The tool 20 exerts a force on the outwardly facing end of the seal 5 and, by virtue of an abutment means or stop 18 provided at the inner end of the seal that prevents the seal from moving inwardly along the injection pipe 9, the seal will be compressed axially and therewith expand radially so as to come into sealing abutment with the inner wall of hole 4. Provided at the outwardly facing end of the seal is some type of locking device that prevents the seal from sliding back outwardly and return to its non-expanded state subsequent to removing the clamping tool 20. The locking device will preferably be comprised of locking washers or plates 19 in the form of a known particular type of spring washer.

Figures 3 and 4 illustrate a second embodiment of an arrangement 1 for injecting and securing a reinforcing element and/or anchoring element 2 in a rock wall 3, in accordance with the present invention. In the case of this second embodiment, the injection means differs from the injection means of the first embodiment, in that the expandable seal consists in this case of a second variant in the form of a pneumatically or hydraulically expandable seal 50. The seal 50 thus has the form of a sleeve which includes double walls and which can be expanded with the aid of a pressurized medium delivered into the sleeve, i.e. into the space between said walls. According to this second embodiment, the injection means therefore includes means for delivering said pressurized pneumatic or hydraulic medium 58. Thus, in addition to the means 7 for connecting the injection means to an injection medium supply means, as shown at 8, the injection means also includes means 51 for connection to a pneumatic or hydraulic pressure source, not shown. A connecting line 52 is provided between the connection means 51 and the space between the walls of the sleeve-like seal, so that pressurized medium is transported to the space between the double walls and therewith cause the seal 50 to expand; see Figure 4. Other parts of the injection means are the same as those in the first embodiment, with the exception that the use of locking washers or plates at the outwardly facing end of the seal is not necessary in the case of the second embodiment. Nevertheless, the material from which the seal is made is an elastic, springy material or a material that is non-rigid, such as a rubber material, so that its form can be changed.

The coupling means 15 in both embodiments has the form of a truncated cone that has an internal thread 16. The conical shape of the coupling means is primarily intended to facilitate release of said means from the injected material 8 subsequent to said material having hardened, whereafter the injection means 1, including the coupling means 15, shall be removed completely from the hole 4. The coupling means 15 may also be treated on its outer surface with a removal facilitating means, for instance with a Teflon coating or a coating of some elastic material. Alternatively said outer surface may be greased.

The inventive method will now be described with reference to Figures 5:1-8 and 6:1-6, these figures being related to the first and the second embodiment respectively.

Figures 5:1 and 6:1 illustrate respectively a rock wall 3 in which a hole 4 has been drilled, this being the normal procedure. Figures 5:2 and 6:2 illustrate respectively the insertion of a reinforcing and/or anchoring element 2 into the hole 4 in the rock wall 3. The element 2 is coupled to an injection means 1 which constitutes a separate unit and includes a means 15 for coupling the injection means 1 to the reinforcing and/or anchoring element 2, connecting means 7 being intended for connection to a means for the supply of injection medium 8, an injection medium check valve 10 and an expandable seal 5 and 51 respectively.

Figure 6:2 also shows the expansion of the seal 50 of the injection means, which in this case is achieved with the aid of a delivered hydraulically or pneumatically pressurized medium, such as water or air for instance. Figure 6:3 shows the appearance of the expanded seal 50. The seal 50 is in sealing abutment with the injection pipe and all the walls of the hole and prevents injection medium injected into the hole 4 from flowing out of the hole during and after the injection phase. Correspondingly, Figure 5:2 shows how the first variant of seal 5 is expanded mechanically with the aid of a tool 20.

Figures 5:4 and 6:3 illustrate delivery of injection medium 8 to the hole 4, via said injection means 1 with its coupling means 7 for connection to the injection medium delivery means, and the injection pipe 9 and the check valve 10. The cavity in the hole 4 and around the reinforcing element 2 is filled with injection medium 8 and when the cavity is full, the injection medium is pressed out into rock cracks and fissures that open into the hole 4, by virtue of the overpressure to which the injection medium is subjected.

Respective Figures 5:5 and 6:4 show the injection means 1 and the hole 4 after completion of the injection phase, while the injection medium 8 is allowed to harden.

Figure 6:4 also shows how the expandable seal 50 is caused to return to its non-expanded state after completion of the injection phase and after the injection medium 8 has hardened at least partially. This is achieved by either returning the pressurized expansion medium to the pressure source or releasing it to the surroundings. With regard to the mechanically expandable seal 5, Figure 5:6 shows how the seal is allowed to return to its non-expanded state by removing the locking washers 19.

Respective Figures 5:7 and 6:5 illustrate the removal of the injection means 1, comprising the means 15 for coupling the injection means to the reinforcing and/or anchoring element 2, the check valve, seal and injection medium delivery means. The injection means can thus be released from the reinforcing element, by unscrewing the coupling means 15 from the reinforcing element 2.

Finally, respective Figures 5:8 and 6:6 illustrate the hole 4 subsequent to the removal of the injection means. As will be evident from the figures, the reinforcing element 2 leaves in the hole 4 a free end 17 which can be used to secure diverse equipment, as earlier described. Naturally, it is also possible to fill the remainder of the hole with injection medium or with some other type of filler if so preferred.

Figures 7 and 8 illustrate a third embodiment of an injection means 1 and the attachment of a reinforcing element and/or anchoring element 62 in a rock wall 3, in accordance with the present invention. This embodiment differs from the two earlier embodiments, primarily by virtue of the fact that the coupling means 65 is also hollow, i.e. provided with a through-passing aperture or bore. In this case, the check valve 10 is located between the front end of the injection pipeline and the aperture in the coupling means 65. When also including a hollow reinforcing element 62, this enables injection medium to be fed right up to the innermost end of the reinforcing element, where the medium is then pressed out into the hole 4. It is then possible, in particular, to allow the reinforcing element 62 to comprise a drill rod that has an internal channel, i.e., in principle, a thick-walled pipe which is fitted with a drill bit 63 at its front end. This embodiment can thus be used to first drill the

hole 4 in the rock wall 3, prior to said injection phase and the affixation of the reinforcing element 62. The coupling means 65 is also conveniently provided with an internal thread 66 in this case, for connection with an external thread 67 on the drill rod 62.

In the case of the third embodiment, the expandable seal 60 is comprised of a mechanically expandable seal.

This third embodiment also includes means 7 for the supply of injection medium 8. This supply means may consist of a swivel device. The injection pipe 9 includes an extension 68 along the supply means. This extension is intended for connection to a drilling machine and is preferably solid. The hole is drilled by relatively slow rotation of the drill rod, at a speed of about 100 – 200 rpm, preferably combined with a certain amount of impact energy.

In order to achieve rotation of the drill rod 62 via the injection pipeline and its extension 68, it is necessary to mount the injection medium supply means 7 on the injection pipe in a manner to prevent rotation of said supply means as other components rotate. In this connection, it is convenient to use a separate expansion device 69 for the seal 60, this expansion device being the subject of an individual, separate patent application filed on the same day as the present application and by the same applicant. This expansion device 69 may be placed around the injection pipe 9 in a manner which prevents it from rotating with the injection pipe. This expansion device is based on a piston-cylinder-device and is controlled either pneumatically or hydraulically.

The arrangement and method according to this third embodiment function in accordance with the following. The drill bit 63, which is of a disposable type, a so-called lost bit, a drill rod 62, the injection means 1, the injection medium supply means 7 and preferably also the separate expanding device 69 are assembled together and connected to a drilling machine. Drilling of the hole is commenced, alternatively there is used an existing hole of some kind, and the arrangement is inserted as far as possible into the hole before starting the drilling phase. Drilling is terminated when a desired bore depth has been reached, and the seal 60 is then expanded so that the entire device will be held firmly in the hole by means of friction. The injection medium 8 is then delivered at an overpressure through the arrangement and out into the hole, via the drill bit 63 which includes suitable channels to this end. The injection phase is terminated and injection medium

allowed to harden. The expandable seal 60 is then caused to return to its non-expanded state, by releasing the pressure in the expansion device 69. The entire arrangement can then be loosened from the drill rod 62 by unscrewing the coupling means 65 from the end of the drill rod and the entire arrangement can be removed optionally for use in a further hole. The drill bit thus remains in the hole together with the firmly injected drill rod and functions as a reinforcing element and can also be used as an anchoring element when it has a free end similar to that obtained in the other described embodiments.

It should be added that although the injection pipe and the coupling means of all illustrated embodiments have been shown as being a single unit it will be understood that this is not a requirement of the actual concept of the invention.

It will also be understood that it is, of course, also conceivable to include a variant of the invention that is adapted for a non-hollow drill rod which is connected to the coupling means and used to drill the hole and then function as a reinforcing or anchoring element. Such a variant would then include coupling means, check valve and seal constructed in accordance with the principle illustrated in the two first embodiments, while the injection medium supply means and the hole sealing expansion means must be designed to permit rotation of other components, corresponding to that illustrated in Figures 7 and 8 respectively.

Figure 9 shows how the free end 17 of the reinforcing element 2 in the hole 4 can be used to attach equipment. In this case there is included a threaded rod 30 that carries a washer 31 and a nut 32 which is used to tension the rock itself by tightening the nut and/or for fastening, e.g., a reinforcing net or the like. An internally threaded sleeve 33 of a known kind is used as a coupling means between the reinforcing element and the threaded rod.

It will be understood that the invention is not restricted to the illustrated exemplifying embodiments thereof, and that modifications and changes can be made in various ways by the person skilled in this art within the scope of the accompanying claims.

CLAIMS

1. An arrangement (1) for injecting and affixing a reinforcing and/or anchoring element (2) in a hole (4) in a rock wall (3), wherein the arrangement (1) includes a means (15; 65) for connection to a reinforcing and/or anchoring element (2; 62), an injection pipe (9) which is connected to said coupling means at a front end facing in towards the hole and which also includes means (7) for connection to an injection medium supply means (8), wherein the arrangement also includes a check valve (10) for co-action with the injection medium (8) and an expandable seal (10; 50; 60) **characterized in that** the arrangement consists of a separate unit that can be released from the reinforcing and/or anchoring element (2; 62) upon completion of the injection phase.

2. An arrangement according to claim 1, **characterized in that** the coupling means (15; 65) includes an internally threaded coupling for connection with an externally threaded end (17) of the reinforcing and/or anchoring element (2; 62).

3. An arrangement according to any one of the preceding claims, **characterized in that** the coupling means (15; 65) and the injection pipe (9) comprise a single entity.

4. An arrangement according to any one of the preceding claims, **characterized in that** the coupling means (15; 65) is designed to facilitate release from the surrounding injected material upon completion of the injection phase and subsequent to hardening of said material.

5. An arrangement according to any one of the preceding claims, **characterized in that** the arrangement can be re-used.

6. An arrangement according to any one of the preceding claims, **characterized in that** the seal (10; 50; 60) has the form of a sleeve disposed around the injection pipe (9).

7. An arrangement according to claim 6, **characterized in that** the seal (10; 50; 60) has the form of a mechanically expandable sleeve.

8. An arrangement according to claim 6, **characterized in that** the seal (10; 50; 60) has the form of a sleeve that includes double walls and that can be expanded by injecting pressurized medium in between said walls.

9. An arrangement according to claim 8, **characterized in that** the arrangement includes means for delivering pressurized medium to the seal (10; 50; 60).

10. An arrangement according to any one of claims 1 - 9, **characterized in that** the check valve (10) is located in the front end of the injection pipe (9).

11. An arrangement according to any one of claims 1 - 9, **characterized in that** the coupling means (15; 65) has an axially extending through-penetrating aperture or bore and is designed to enable it to be coupled to a tubular element forming said reinforcing and/or anchoring element (2; 62), and in that the check valve (10) regulates the supply of injection medium (8) from the injection pipe (9) via the aperture in the coupling means, and through said tubular element and out at the front end of said element.

12. An arrangement according to claim 11, **characterized in that** the tubular element forming said reinforcing and/or anchoring element (2; 62) is a drill rod (62) which has an internal channel and which is provided with a drill bit (63) for drilling said hole (4), and in that said check valve (10) regulates the supply of injection medium (8) from the injection pipe (9) via the aperture in the coupling means (15; 65), and through said drill rod (62) and out through the drill bit (63).

13. A method of injecting and affixing a reinforcing and/or anchoring element (2; 62) in a rock wall (3), said method comprising the steps of:

- inserting in a hole (4) in the rock wall (3) a reinforcing and/or anchoring element (2; 62) coupled to an injection arrangement which constitutes a separate unit and which includes means for connection to a reinforcing

and/or anchoring element, an injection pipe (9) which is connected to said coupling means at a front end facing inwardly in the hole (4) and which includes means for connection to an injection medium (8) supply means, wherein the arrangement also includes a check valve (10) for co-action with the injection medium (8), and an expandable seal (5),

- expanding the seal (5) of the injection arrangement, said seal (5) being able to prevent injection medium (8) injected into the hole (4) from flowing out of the hole (4) during and after the injection phase,
- delivering injection medium to the hole (4) via said injection arrangement and said check valve (10),
- terminating the injection phase and allowing the injection medium (8) to harden,
- causing the expandable seal (5) to return to its non-expanded state upon completion of the injection phase and after at least partial hardening of the injection medium (8), and
- removing the injection arrangement as a unit.

14. A method according to claim 13, **characterized by** drilling the hole (4) with the aid of a drill rod (62) provided with a drill bit (63), said drill rod (62) later forming said reinforcing and/or anchoring element (2; 62); and by drilling said hole when the injection arrangement has already been coupled to the reinforcing and/or anchoring element (2; 62).

15. A method according to claim 14, **characterized by** carrying out said injection phase through the medium of a through-penetrating aperture in the coupling means, and via an internal channel in the drill rod (62) and out into the hole via the drill bit (63) fitted to the front end of the drill rod (62).

16. A method according to any one of claims 13 - 15, **characterized by** injecting the injection medium (8) at an overpressure, wherewith the hole (4) is first filled with injection medium (8) which thereafter penetrates into any cracks that may be present in the rock (3) and that open out into the hole (4), therewith sealing the cracks.

17. A method according to any one of claims 13 - 16, **characterized by** re-using the injection arrangement for injecting and affixing a new reinforcing and/or anchoring element (2; 62) in said rock wall (3).

18. A method according to any one of claims 13 - 17, wherein a free end of the reinforcing and/or anchoring element (2; 62) will remain in the hole (4) sealed with said injection medium (8) subsequent to removal of the injection arrangement, this free end being used for the attachment of further equipment.

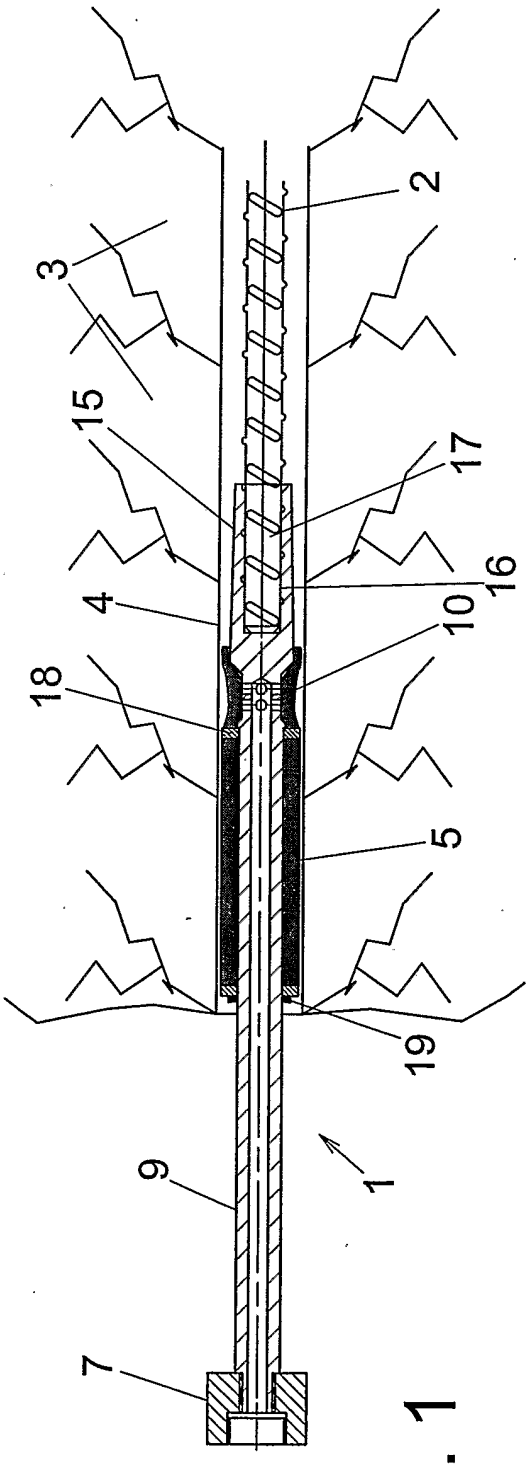


Fig. 1

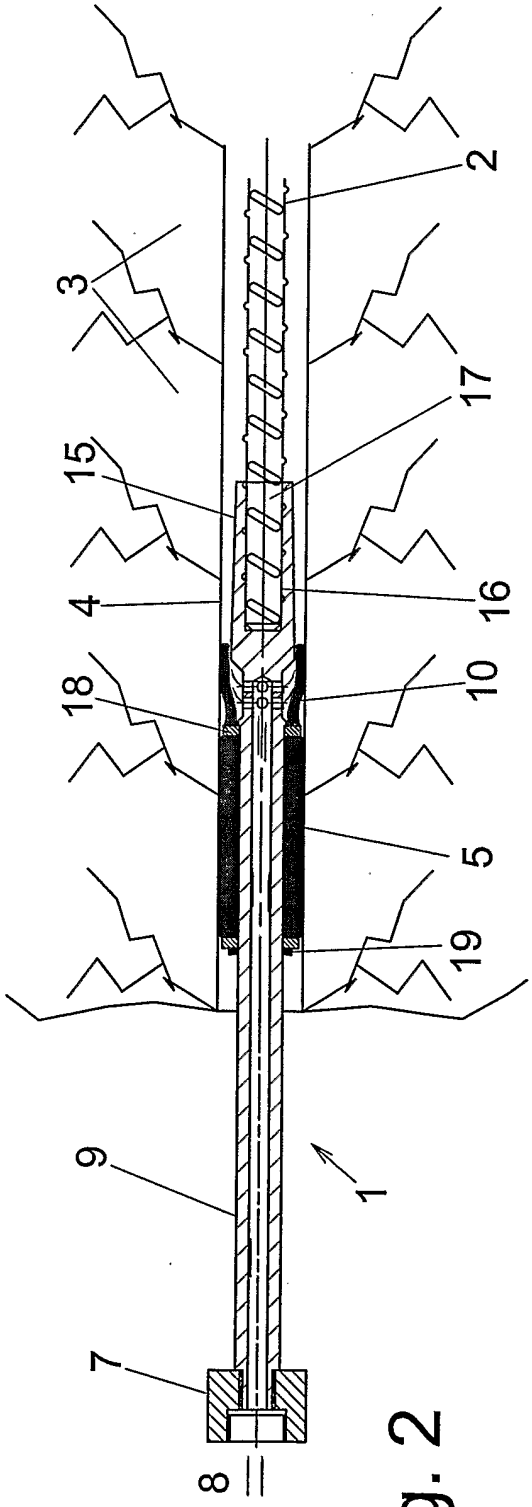


Fig. 2

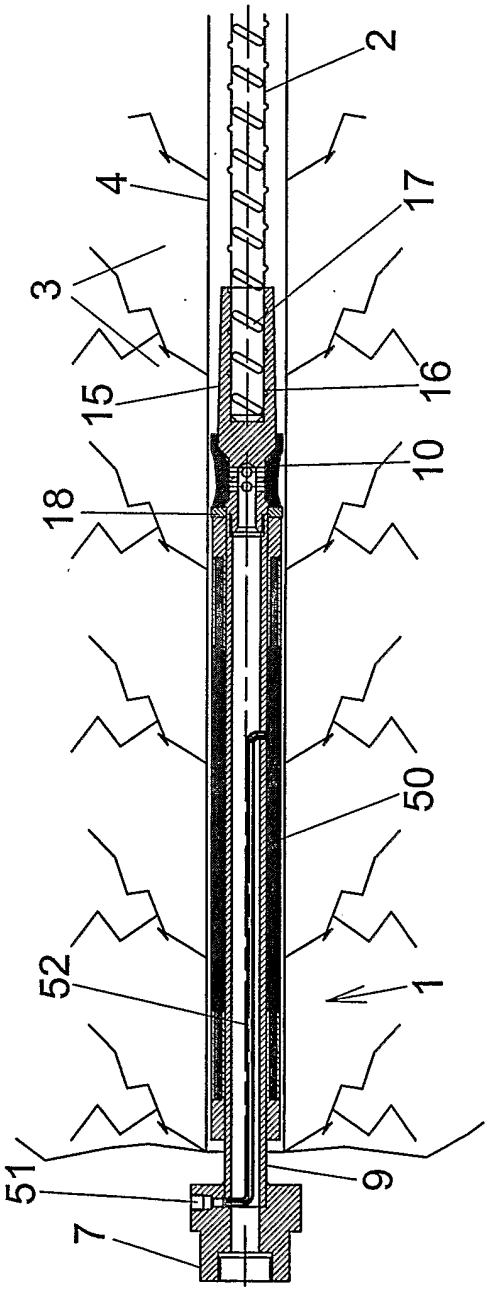


Fig. 3

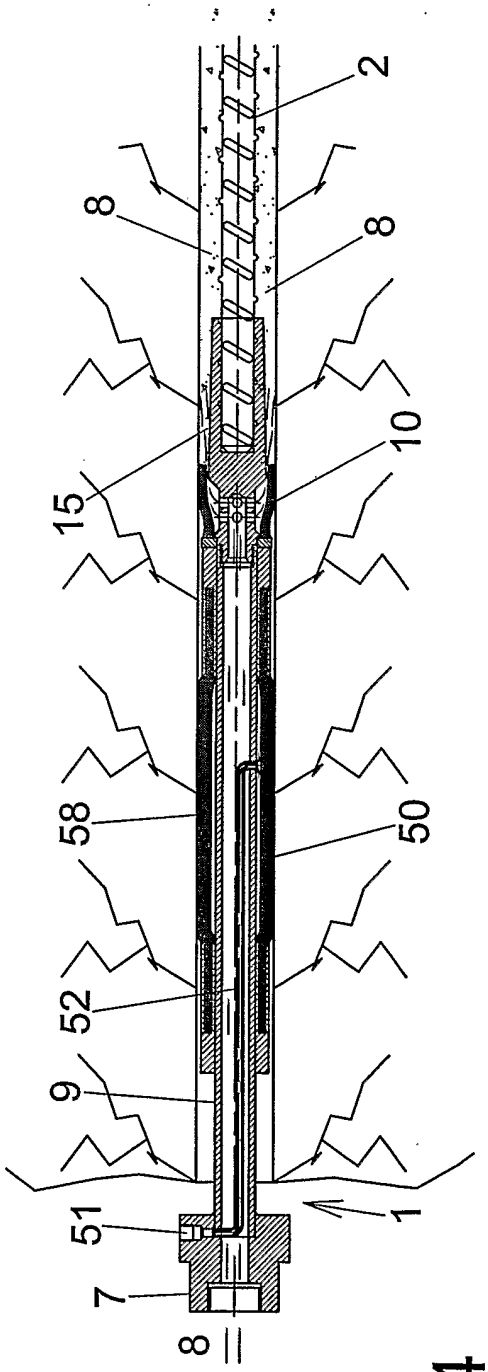


Fig. 4

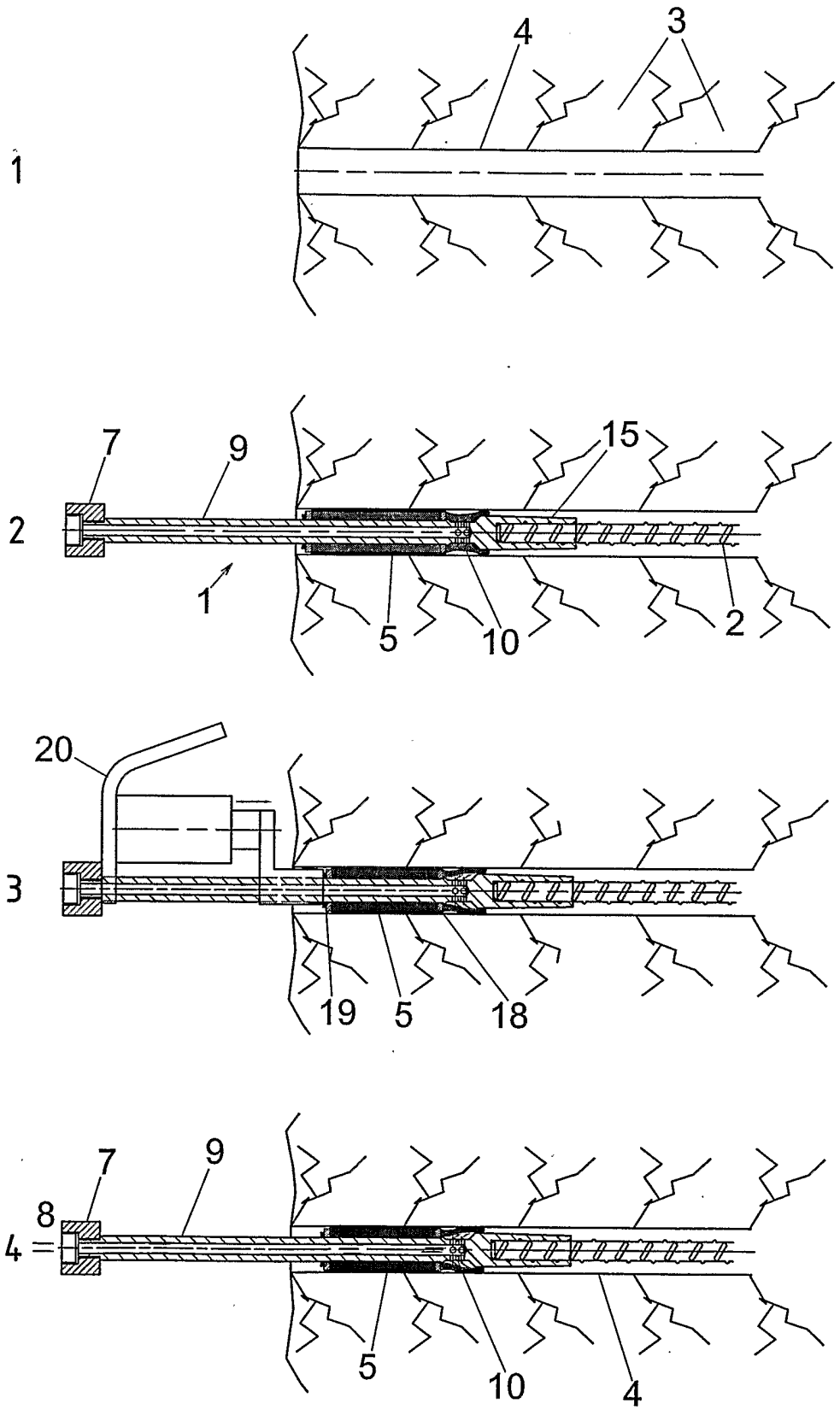


Fig. 5:1-4

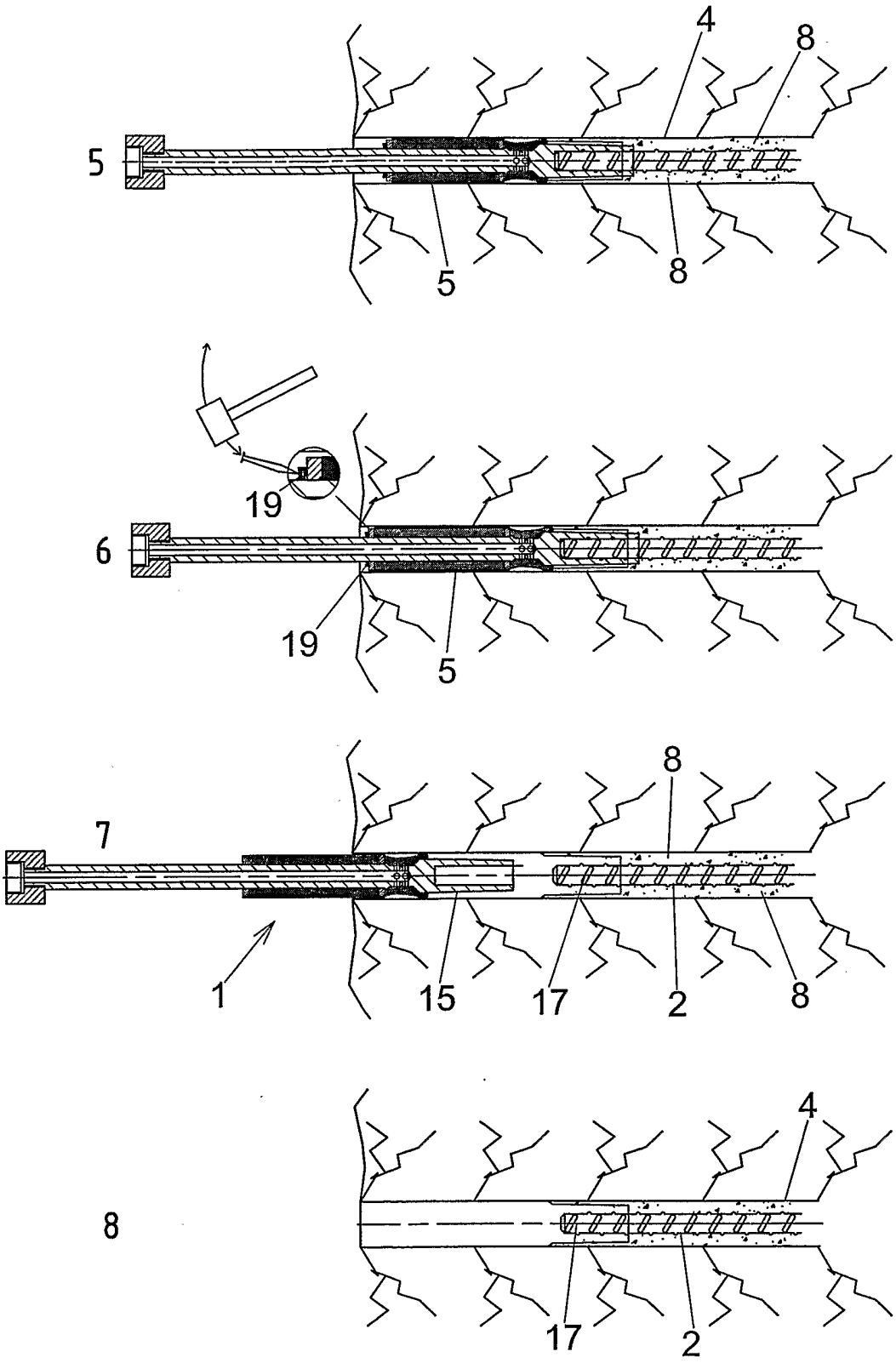


Fig. 5:5-8

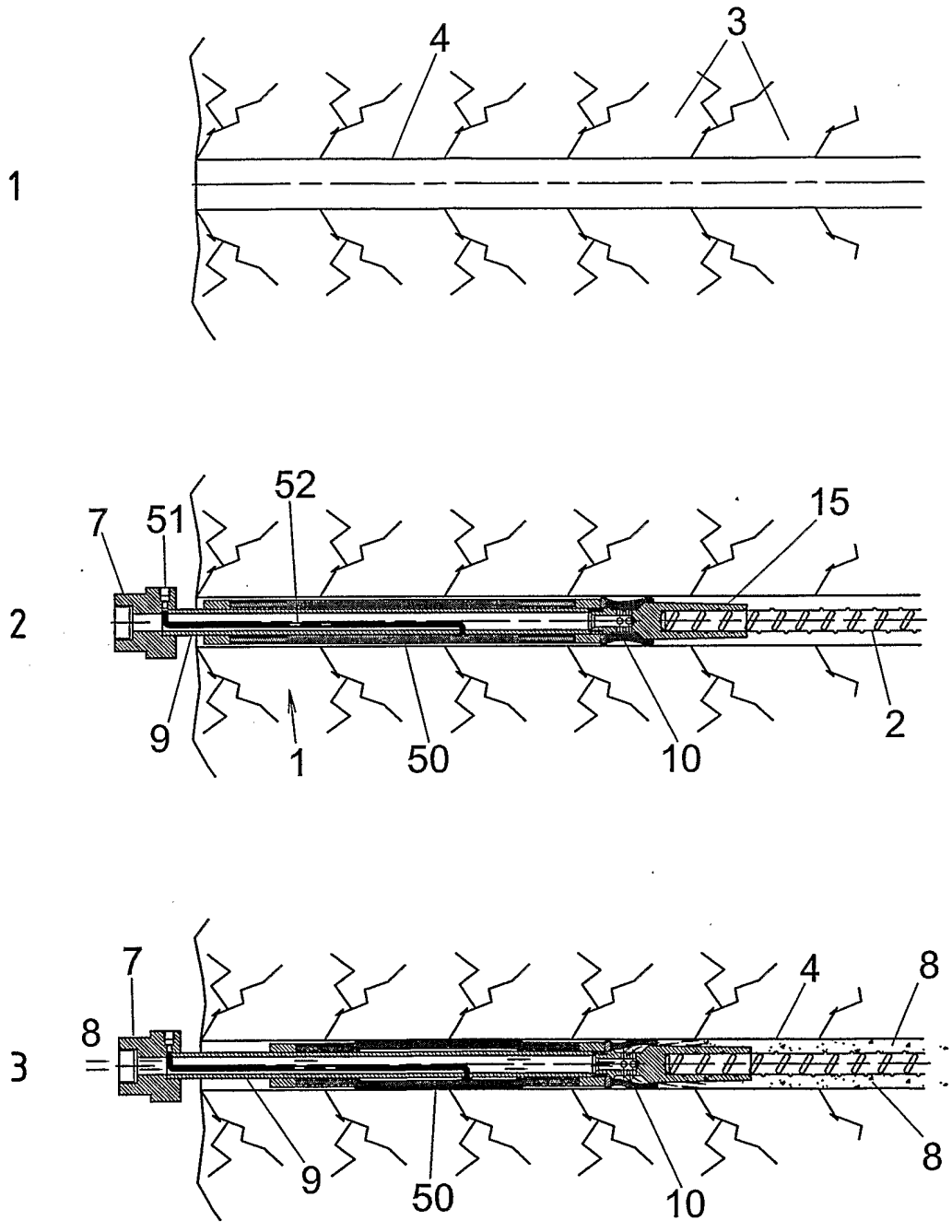
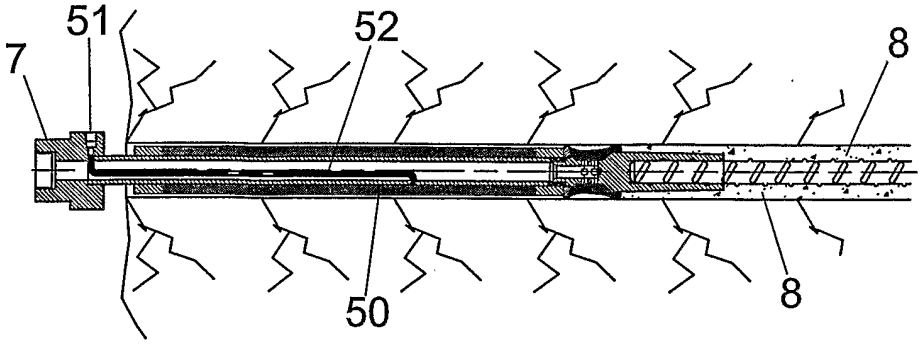


Fig. 6:1-3

4



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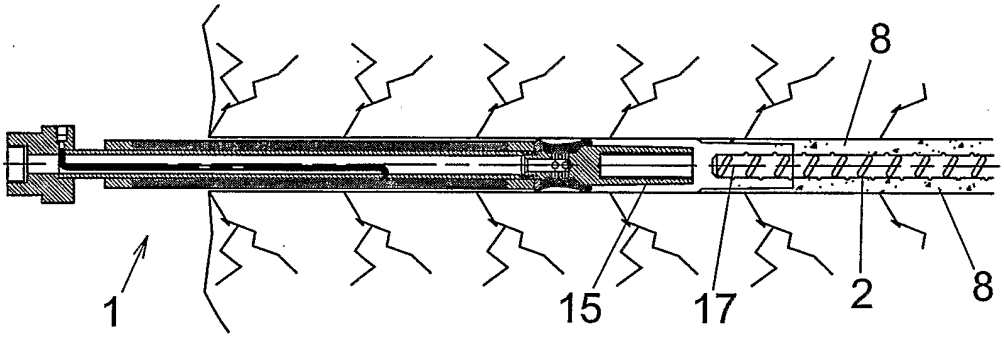

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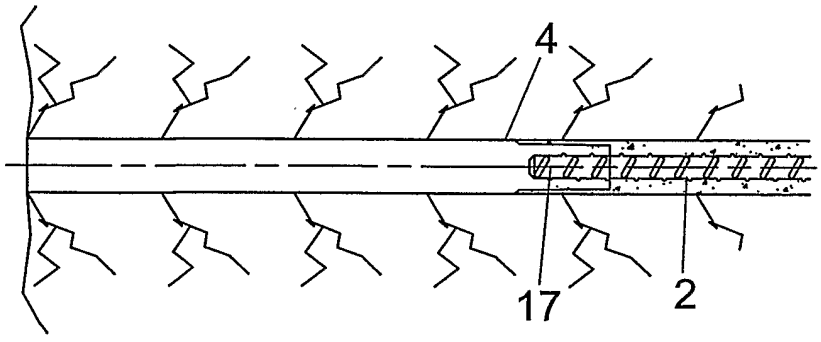
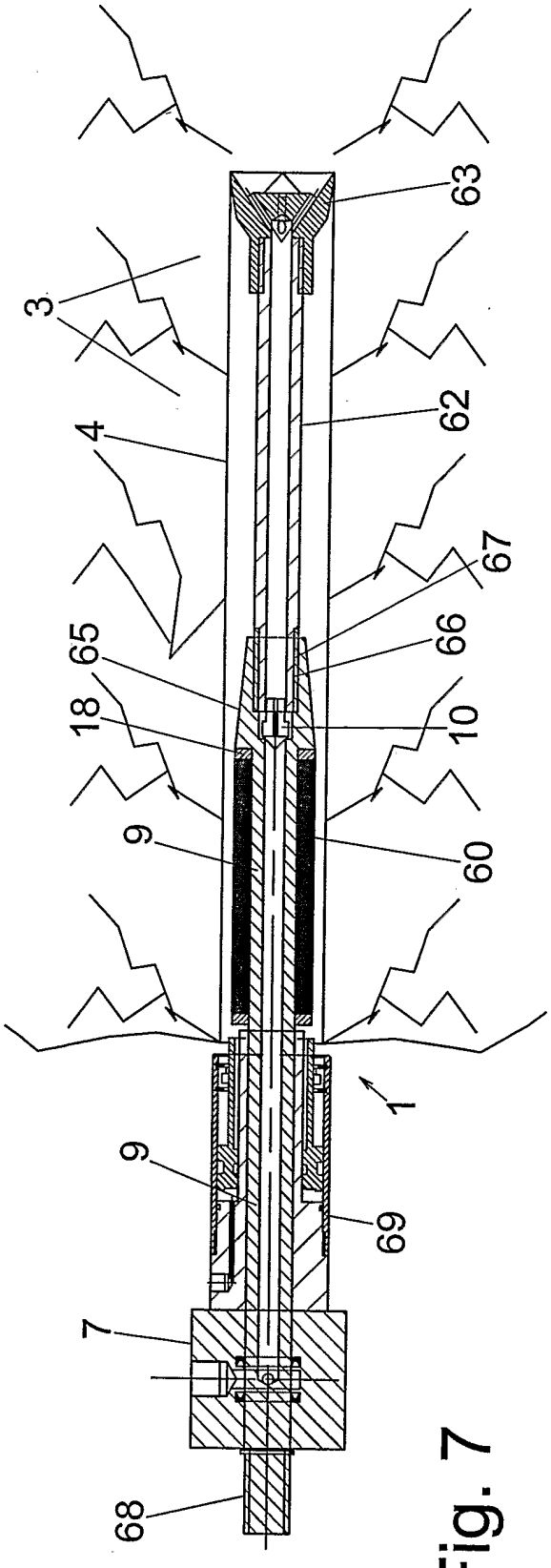


Fig. 6:4-6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62
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67
66
65
18
10
9
60
1
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69
7
68

Fig. 7

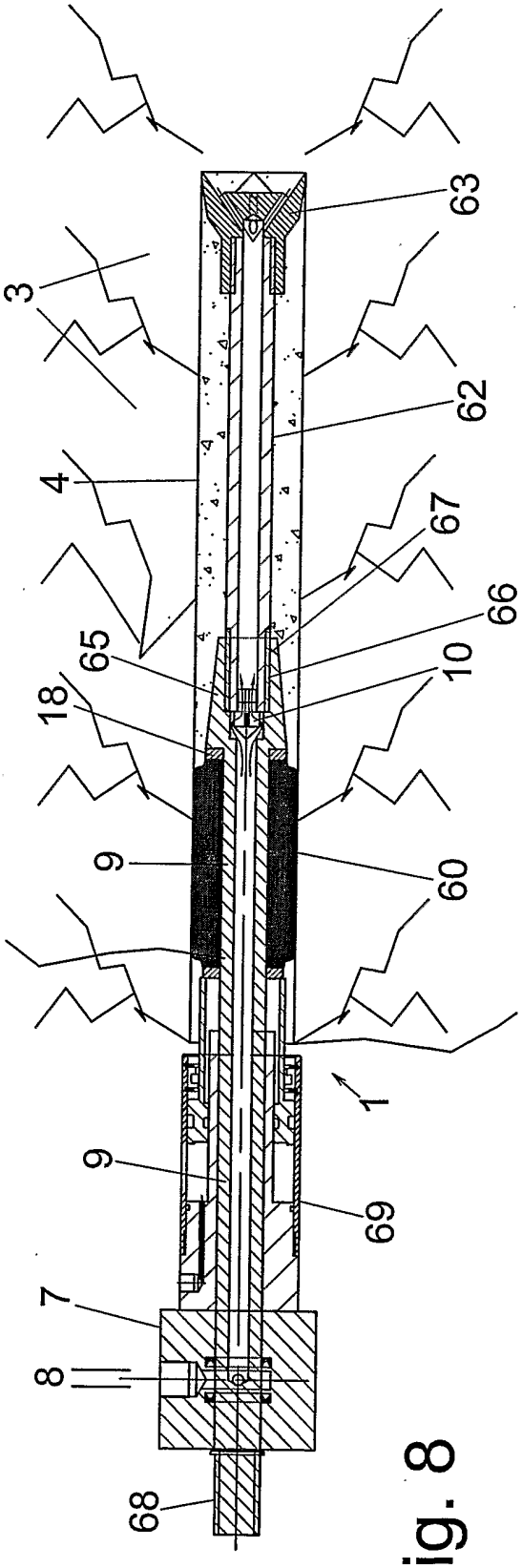
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Fig. 8

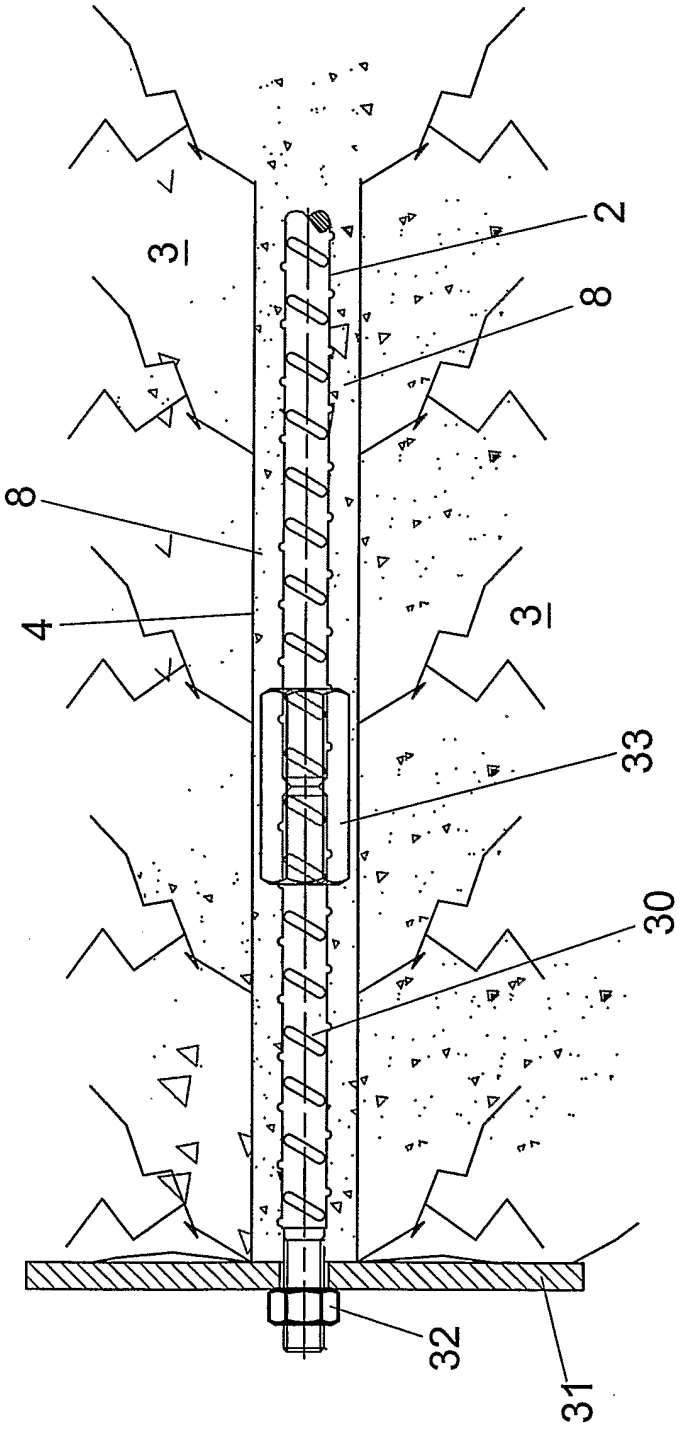

Fig. 9

INTERNATIONAL SEARCH REPORT

International application No.
PCT/SE 2005/001133

A. CLASSIFICATION OF SUBJECT MATTER

IPC7: E21D 20/02
According to International Patent Classification (IPC) or to both national classification and IPC

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)

IPC7: E21D

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

SE,DK,FI,NO classes as above

Electronic data base consulted during the international search (name of data base and, where practicable, se arch terms used)

EPO-INTERNAL, WPI DATA, PAJ

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
A	DE 2926155 A1 (STUMP BOHR AG), 28 August 1980 (28.08.1980) --	1-18
A	US 4158519 A (D.W. GAMLIN), 19 June 1979 (19.06.1979) --	1-18
A	WO 9845576 A1 (SKANSKA ANLÄGGNING AB), 15 October 1998 (15.10.1998) --	1-18
A	WO 9956001 A1 (ERIKSSON, H.), 4 November 1999 (04.11.1999) --	1-18

☐ Further documents are listed in the continuation of Box C. ☒ See patent family annex.

* Special categories of cited documents:
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"E" earlier application or patent but published on or after the international filing date
"L" document which may throw doubts on priority claim(s) or which is cited to establish the publication date of another citation or other special reason (as specified)
"O" document referring to an oral disclosure, use, exhibition or other means
"P" document published prior to the international filing date but later than the priority date claimed
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"X" document of particular relevance: the claimed invention cannot be considered novel or cannot be considered to involve an inventive step when the document is taken alone
"Y" document of particular relevance: the claimed invention cannot be considered to involve an inventive step when the document is combined with one or more other such documents, such combination being obvious to a person skilled in the art
"&" document member of the same patent family

Date of the actual completion of the international search	Date of mailing of the international search report
27 Sept 2005	29-09-2005
Name and mailing address of the ISA/ Swedish Patent Office Box 5055, S-102 42 STOCKHOLM Facsimile No. +46 8 666 02 86	Authorized officer Christer Bäcknert / MRo Telephone No. +46 8 782 25 00

INTERNATIONAL SEARCH REPORT

Information on patent family members

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INTERNATIONAL SEARCH REPORT

Information on patent family members

31/08/2005

International application No.

PCT/SE 2005/001133

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