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

(11) **EP 3 184 732 A1**

(12) **EUROPEAN PATENT APPLICATION**

(43) Date of publication:
28.06.2017 Bulletin 2017/26

(51) Int Cl.:
E21D 9/00 *(2006.01)* ***E21D 20/02*** *(2006.01)*

(21) Application number: **16206348.1**

(22) Date of filing: **22.12.2016**

(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 MD

(30) Priority: **22.12.2015 SE 1551697**

(71) Applicant: **Veidekke Entreprenad AB**
746 40 Balsta (SE)

(72) Inventor: **Stoor, Joakim**
740 10 ALMUNGE (SE)

(74) Representative: **Noréns Patentbyrå AB**
Box 10198
100 55 Stockholm (SE)

(54) **METHOD AND ARRANGEMENT FOR THE INJECTION OF ROCK AND SOIL MATERIAL**

(57) A method and an arrangement for the injection of rock or soil material, for example injection into boreholes in correlation with tunnelling, the excavation of rock caverns, or during the construction of dams. Grout from a common supply pump (1) is pumped at the same time through several injection pipes (3) to several injection holes (A-G), and where at least the pressure (10) and injected volume (9) are monitored and individually measured by a control unit for the supply to each one of the said injection holes (A-G), and where the control unit (11), at a final interruption of the injection of an injection hole (A-G), regulates a valve arrangement (4) such that no grout is any longer fed to the injection pipe (3) that leads to the relevant injection hole (A-G) and instead connects a water line (6) for the supply of water to the valve arrangement (4) and the injection pipe (3) for the rinsing clean of these. The arrangement comprises a pressure sensor (10) and a flow gauge (9) for each injection pipe (3) connected to a monitoring arrangement (11) in order to, for each one of the injection pipes (3) of injection holes (A-G), record the pressure and the volume of the supplied grout that has been injected.

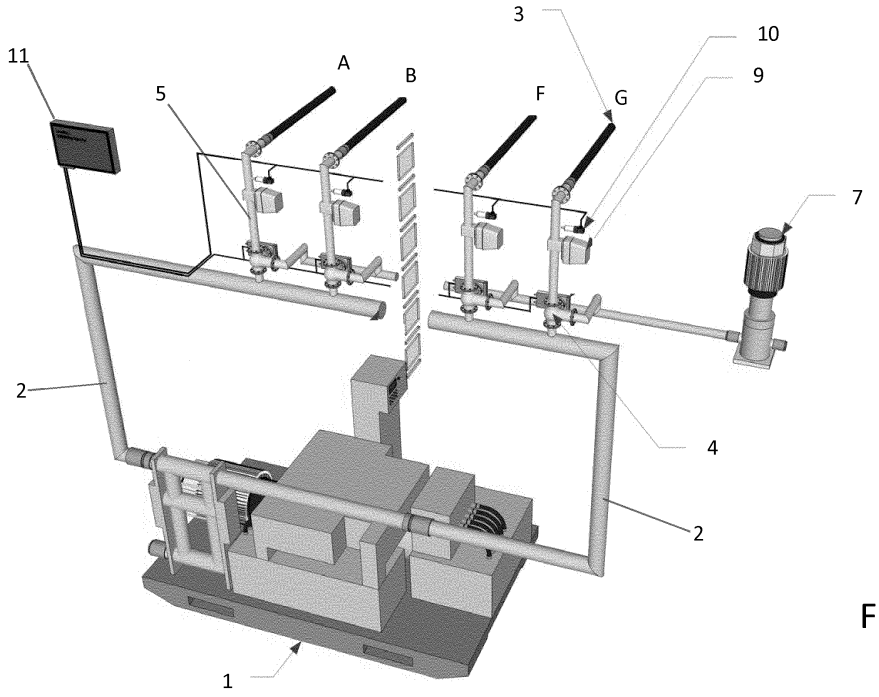

Fig. 1

EP 3 184 732 A1

Description

[0001] The present invention concerns a method and an arrangement for the injection of rock or soil material, for example injection into boreholes in correlation with tunnelling, the excavation of rock caverns, or during the construction of dams, and in particular such that it is possible to carry out injection more rapidly and efficiently than has been possible until now. Injection involves an injection material, normally a cement-like mixture, being introduced into the borehole before blasting in order to seal the natural fracture structure of the rock, and in this way prevent the penetration of water through the rock after a tunnel has been blasted.

[0002] Thus, injection is part of the work of tunnelling, and normally consists of a number of steps, such as the drilling of injection holes → cleaning the holes → in certain cases the measurement of water loss → injection → a period of delay → and finally tunnelling. The various steps of the process must be carried out one after the other, since they influence each other, and since the actual injection is one of the parts that takes the longest time, it is of great interest to be able to reduce the time that this part of the process takes.

[0003] When the rock has been cleared after a blasting salvo and after reinforcement, where necessary, has been carried out, the drilling of what is known as the "injection screen" starts. The number of holes and their depth and location differ between different projects and are normally determined based on a defined sealing class and tunnel size. It is most commonly the case that injection holes are drilled with a diameter of 64 mm and with a depth of approximately 20 m. At the same time as the holes are drilled, they are flushed clear using high-pressure with the aid of the drilling unit, until the flushing water no longer contains drilling cuttings. The flushing is important such that the grout that is used during injection can penetrate the fractures that are present, which otherwise may be clogged by remaining cuttings. While the drilling is taking place, the injection equipment can be prepared.

[0004] The injection operation starts when the injection unit is driven forwards. The injection unit may be mounted on a separate vehicle, or on a platform that can be displaced forwards by other means to the position at which the injection is to be carried out. Electricity and water are connected to the injection unit. Pipes are connected between the injection components and everything is flushed clean. Sleeves are mounted onto the nozzles and pipes are laid. Once these preparations are complete, the first grouting mix is mixed and the injection operation itself can start.

[0005] Often, the lowermost holes are initially injected, and this is carried out by a nozzle with a single-use sleeve being introduced into the hole that is to be injected. The grouting mix that has been prepared is pumped through pipes and nozzles into the drilled injection holes until grout is expelled from the injection hole instead of water, which means that the complete dead volume of the hole has been filled with grout. After this the sleeve is inflated and in this way anchored in the mouth of the hole, after which the pressure can be increased and injection beyond the dead volume of the hole can start, in order for the grout to penetrate into fractures that are in contact with the injection hole.

[0006] During injection, as has been mentioned above, it is most often the holes at the bottom that are first injected, and in this case the most centrally located of them, and then to continue outwards, and then to continue horizontally upwards, and finally to the holes on the upper surface of the tunnel being constructed. It is normal that two holes are injected simultaneously. When the holes change direction from being directed downwards to being directed upwards, which normally takes place in the upper part of the horizontal row of holes, the sleeve at the mouth of the hole must be inflated immediately, in order to prevent the grout that has been pumped in from running out.

[0007] During injection, stop criteria have been specified to determine when the injection of a hole is to be considered to be complete. These stop criteria are normally a specified maximum pressure that is to be achieved for a hole, or a maximum injection volume. Alternatively, also a maximum injection time may be specified, in the case in which none of the other criteria interrupts the injection.

[0008] If an injection hole is filled to its maximum permitted volume without the stop pressure being reached when using the first grouting mix, a thicker grouting mixture is used for subsequent injections. Two or three different w/c ratios are normally stipulated, where work starts using the least thick and ends with the most thick. Injection continues in this manner until all holes in the injection screen have been injected and satisfied the stop criteria.

[0009] When the final hole in an injection screen has been injected, cleaning of the equipment is started, together with flushing and dismantling of pipes and nozzles, before the injection equipment is moved away from the current injection location.

[0010] With prior art technology two people have normally been required to operate the equipment, one of whom has controlled and monitored the mixers and pumps and one of whom has monitored the pipes and moved them between the various injection holes. Thus, two people cannot manage to handle more than two injection holes at the same time, and the injection in this way consumes a considerable period, in particular when it is remembered that an injection screen can comprise 20 holes or more.

[0011] Through SE 407 604 B an injection arrangement is previously known that is principally intended for the manual operation of the valves that are components of the system. Even though a limit to how many simultaneous boreholes can be injected is not specified, it has proved to be the case in practice that it is not possible to

carry out more than four simultaneous boreholes, due to, among other things, the manual handling that is required.

[0012] As also is made clear by the above-mentioned document, the valve of an injection pipe is not closed when it is assessed that the current injection hole has been filled. Instead, the flow regulation valve is regulated such that the flow is cut off, and the injection pipe is subsequently disconnected from the borehole. The injection pipe is instead led back to the preparation unit, and in this way back to the injection pump and distribution chamber. It is also stated in the said document that it is necessary at certain intervals to considerably increase the flow-through area of the constricted distribution valve for a short period, in order to create pressure pulses in order to prevent the injection mixture solidifying in the flow regulation valves.

[0013] A further problem, which is not discussed in the said document, is that the constriction of the flow valves gives rise to significant wear of these through the severe abrasive effect that the grout has, and that they in this way are given a shortened lifetime and must be exchanged.

[0014] The purpose of the present invention is to achieve a method and an arrangement adapted for this method in order to be able to inject several holes at the same time in order to be able to speed up the injection operation.

[0015] This aim of the invention is achieved with a method for the injection in which the control unit, at a final interruption of the injection of an injection hole, regulates a valve arrangement such that grout is no longer fed to the injection pipe that leads to the current injection hole and instead connects a water line for the supply of water to the valve arrangement and the injection pipe for the rinsing clean of these.

[0016] According to one preferred embodiment of the method according to the invention, also the duration of the injection in an injection hole is monitored for each one of the injection holes.

[0017] According to a further preferred embodiment of the invention, the injection is monitored with the aid of the control unit into which has been input for each injection hole an upper limiting value for each one of pressure, injected volume and possibly also duration, and which control unit, in the event that the limiting value that has been input is reached, is arranged to interrupt the injection into the injection hole for which the limiting value has been reached.

[0018] The purpose to achieve an arrangement that is adapted such that it is able to inject several injection holes at the same time according to the method according to the invention is achieved through the arrangement comprising a pump for grout connected to several injection pipes, each one of which is connected to an injection hole for the simultaneous feed of grout to the injection holes that are connected, whereby the arrangement for each injection pipe comprises also a pressure sensor and a flow gauge connected to a surveillance arrangement or control unit, and where the arrangement comprises also a water line that is connected through a valve arrangement for the supply of rinsing water to the injection pipe when the control unit has registered that injection into its injection hole is complete and the injection pipe has been disconnected from the relevant injection hole.

[0019] According to one preferred embodiment of the arrangement according to the invention, it comprises also a timer to record the duration during which grout is supplied through the injection pipe to the injection hole.

[0020] According to one preferred embodiment of the arrangement according to the invention, the monitoring arrangement comprises a control unit into which has been input for each injection hole an upper limiting value for each one of pressure, injected volume and possibly also duration, and which control unit, in the event that the limiting value that has been input is reached, is arranged to interrupt the injection into the injection hole for which the limiting value has been reached.

[0021] The invention will now be described in more detail in the form of a preferred but not limiting embodiment of the invention, where **Figure 1** shows a schematic perspective view of an arrangement according to the invention, **Figure 2** shows a flow diagram for a method according to the invention, in the condition just before injection starts, **Figure 3** shows a view corresponding to that shown in Figure 2, but in the condition in which all valves for the injection of grout are open and a certain volume of grout has been injected into each injection hole, **Figure 4** shows a view corresponding to that shown in Figure 3, but in which a pre-determined limiting value for the volume has been reached for one of the injection holes, **Figure 5** shows a view corresponding to that shown in Figure 4, but in which the pre-determined limiting value for pressure has been reached at the same time as the limiting value for the volume has been reached for four of the injection holes, **Figure 6** shows a view corresponding to that in Figure 5, but in which injection continues in the four holes that in Figure 5 had achieved the limiting value for the volume, while other injection pipes are disconnected, and where one of these is being rinsed clean, **Figure 7** shows a view corresponding to that in Figure 6, where the rinsing clean of disconnected injection pipes has been completed and where a new pre-determined limiting value for two of the injection holes has been reached, **Figure 8** shows a view corresponding to that shown in Figure 7, in which the predetermined limiting value for pressure has again been reached at the same time as the limiting value for the volume has been reached for an additional injection hole, **Figure 9** shows a view corresponding to that in Figure 8, but in which the injection continues for the three injection holes for which the limiting value for volume had been reached, while the injection pipe for the injection hole for which the limiting value of pressure had been reached has been disconnected and is now being rinsed clean, **Figure 10** shows a view corresponding to that in Figure 9, but in which the injection pressure has reached a new

pre-determined limiting value, and in which a new limiting value for the volume has been reached for two of the injection holes, **Figure 11** shows a view corresponding to that in Figure 10, in which a new limiting value for the volume has been reached for one of the two remaining injection holes and the injection pressure has been reached for the second remaining injection hole, and **Figure 12** shows a view where a new limiting value for the volume has been reached for the final remaining injection hole, and in which all injection pipes have been disconnected and all valves opened for the rinsing clean of the system.

[0022] Thus, Figure 1 shows schematically a perspective view of an arrangement according to the invention, and that comprises an injection pump 1 in order to feed through a distributor pipe 2 a completed grouting mix to several injection pipes 3, each of which is, in turn, connected to an injection hole. The injection pipes are preferably of hydraulic pipe type, since they must be able to withstand a significantly increased pressure in association with the feed of the grout and maintaining its pressure. A mixer, not shown in the drawings, mixes the components that are to be components of the grouting mix that is to be injected into an injection hole, and the grouting mix is fed with the aid of pumps to the injection pump 1 itself. This is fully prior art technology, and for this reason these parts are not shown or described in more detail.

[0023] A valve, preferably a three-way valve 4, is connected to the distribution pipe 2, as will be described in more detail below, for each one of the several injection pipes 3 that are connected to the injection pump 1. As is shown in the drawing, a pipeline 5 may be arranged between the valve 4 and the injection pipe 3 itself. The injection pipe 3 is at its other end connected in known manner via a sleeve to an injection hole that is to be injected with the grouting mix. Also a water line 6 is connected to the three-way valve 4 for each one of the injection pipes 3, which water line is fed with water by a water pump 7, as will be described in more detail below. Also a regulator 8 is arranged at each three-way valve 4, which regulator can control the function of the three-way valve.

[0024] On the pipeline 5 between the three-way valve 4 and the injection pipe 3, there is furthermore arranged, for each injection hole, a flow gauge 9 arranged to measure the volume of grouting mix that flows through the pipeline 5, and in the same way there is arranged in each pipeline 5 a pressure sensor 10 that records the pressure of the grouting mix inside the pipeline 5, which pressure is assumed to correspond to the pressure in the grouting mix in the injection hole to which the injection pipe is connected.

[0025] The flow gauges 9 and the pressure sensors 10 for each pipeline 5 are connected to a control unit 11 that monitors the flow and the pressure in each one of the pipelines 5, and the control unit 11 is connected also to the regulator 8 for each pipeline 5 in order to be able to regulate individually the setting of the three-way valves 4 that manage the supply to the relevant injection pipes 3. It is appropriate that the control unit 11 comprise a programmable computer, with input means and display means, in order to be able to control the injection process as will be described in more detail below.

[0026] Figure 2 to Figure 12 show schematically in the form of a flow diagram how simultaneous injection of a number of injection holes A, B, C, D, E, F and G is carried out, where the drawings show a distribution pipe 2 at the bottom, together with the water line 6 and the three-way valves 4, which for each injection hole A-G are displayed as circles, where an "X" in any particular circle indicates that the valve 4 is there closed, while a round circle without an "X" indicates that the relevant valve is open. The drawings show also a box 12 with a volume specification, which corresponds in principle to the result that the flow gauge 9 has recorded for each injection hole A-G. The box 12 is not, in practice, present at each injection hole A-G: it is the numerical value that has been recorded in the control unit 11 and can be displayed on its display unit, such as, for example, a computer screen.

[0027] Figure 2 shows the situation before the injection pump 1 has been activated, and in which the pressure in the distribution pipe 2 is zero. All three-way valves 4 are fully closed, and thus they can allow to pass neither grouting mix from the distribution pipe 2 nor water from the water line 6. The boxes with the volume specifications all thus show "0", which corresponds to the amount that the flow gauge has recorded for each pipeline 5.

[0028] Figure 3 shows that a grouting mix with a pressure of approximately 7 bar is supplied to the distribution pipe 2, and since all three-way valves 4 have been opened to allow the supply of grouting mix through the pipelines 5 to the various injection holes A-G, input flow into these occurs, and the flow gauges 9 record the volume that flows through each one of the pipelines 5 and the injection pipes 3 to the injection holes. It is made clear by the numerical values in the relevant boxes 12 that the input flows in the different injection holes A-G differ. As is made clear by the example shown, which could very well correspond to a true case, the flow differs highly between the different injection holes. In the example shown, in the condition shown, the flow ranges from 4 to 37 litres. The difference in injected volume is a consequence of the grout flowing most rapidly into the holes at which it meets the lowest resistance.

[0029] Figure 4 shows a further more advanced condition during the injection process, and where grouting mix continues to flow through the distribution pipe 2, now with an increased pressure in the distribution pipe, and the volumes fed into the injection holes have increased markedly from those in the condition shown in Figure 3, as is made clear by the volume information in the boxes 12. For the injection hole F, the volume information shows that a volume of 100 litres has been fed in, which corresponds to a pre-determined volume criterion for a temporary stop of the injection into this injection hole. The control unit 11 has, therefore, received the information about the volume that has been injected from the flow

gauge 9 connected to the pipeline 5 for the injection hole F, and has then activated the regulator 8 to cause it to close the three-way valve 4 in this pipeline, which is indicated by an X in the circle from the distribution pipe 2. The injection continues in the other injection holes A-E and G.

[0030] Figure 5 shows an even more advanced condition in the injection process with an even further increased pressure in the distribution pipe 2. In this condition also the injection holes B, C and G have reached the pre-determined volume criterion, and the valves 4 have been closed in the pipelines for these injection holes, which is indicated by an X in the circles from the distribution pipe 2. The pressure that is present in the distribution pipe (30 bar) corresponds also to the pre-determined maximum pressure, according to the selected example, and the injection pump 1 is stopped by the control unit in order to maintain the pressure in the injection holes A, D and E, which have not reached the pre-determined volume. The three-way valves 4 from the distribution pipe 2 to these injection holes are held open for a pre-determined duration in order to maintain the pressure (30 bar) in the grouting mix in the injection holes A, D and E. When the pre-determined retention time has passed, also the three-way valves 4 to these injection holes are closed, and the pressure in the distribution pipe 2 is subsequently reduced before the injection is resumed.

[0031] Figure 6 shows a condition in which the injection process has been resumed, and the three-way valves 4 from the distribution pipe 2 to the injection holes B, C, F and G, which were previously closed because they had reached the pre-determined volume criterion, have been re-opened in order to allow continued injection of grouting mix into these injection holes. For injection holes A, D and E, which did not reach the pre-determined volume criterion (100 litres) before the pre-determined maximum pressure was reached, the injection pipes 3 can now be disconnected, which is carried out manually by an operator. The drawing shows by the curved arrows that the injection pipes to injection holes A, D and E have been disconnected, and that for the injection pipe A the three-way valve 4 from the water line 6 has been opened in order to allow rinsing clean of the injection pipe 3. A corresponding rinsing clean operation is subsequently carried out of injection pipes 3 for the injection holes D and E.

[0032] Figure 7 shows a condition during the continued injection in which the volumes for the injection holes B and G have achieved the next pre-determined volume, a total injected volume of 200 litres per injection hole. The control unit 11 in this condition has, with the aid of the regulators 8, closed the three-way valves 4 for these two injection holes such that no grouting mix can be supplied to these, while the pressure is allowed to continue to increase for the injection of grouting mix into the injection holes C and F, for which the three-way valves 4 for the supply of grouting mix from the distribution pipe 2 are continued to be held open.

[0033] Figure 8 shows the condition in which the pressure has risen to 30 bar, which is the pre-determined maximum pressure, and in which also the volume for injection hole C has reached the next pre-determined volume criterion, and at which the control unit has therefore closed the three-way valve for the supply also to this injection hole. For injection hole F, in contrast, the maximum pressure has been reached without the volume reaching the pre-determined volume criterion. The three-way valve 4 from the distribution pipe 2 to this injection hole is held open for a pre-determined duration in order to maintain the pressure (30 bar) in the grouting mix in the injection hole.

[0034] Figure 9 shows that when the pre-determined retention time has passed, also the three-way valve 4 to this injection hole is closed, and the injection pipe to the injection hole F is disconnected during the continued process, and that the pressure in the distribution pipe 2 is subsequently reduced before the injection is resumed and the three-way valves 4 for the supply of grouting mix from the distribution pipe 2 is reopened for the injection pipes that run to the injection holes B, C and G. Also the disconnected injection pipe 3 that was used for the injection hole F is subsequently rinsed clean.

[0035] Figure 10 shows that the next pre-determined volume, a total injected volume of 300 litres per injection hole, has been reached for injection holes B and C during the continued injection. The control unit 11 in this condition has, with the aid of the regulators 8, closed the three-way valves 4 for these two injection holes such that no grouting mix can be supplied to these. At the same time, in this condition also the maximum pressure of 30 bar has been reached for injection hole G, and the pressure has been maintained during the pre-determined duration for this injection hole, after which also the three-way valve 4 to this injection hole has been closed, and the injection pipe has been disconnected such that it can be rinsed clean.

[0036] Continued injection into injection holes B and C subsequently takes place, but it is preferable that a change of grouting mix take place before this continued injection starts. Figure 11 shows the condition in which the maximum pressure of 30 bar has again been reached, and in this case also a new pre-determined volume criterion, a total injected volume of 400 litres, has been achieved for injection hole C. For injection hole B, the pressure has been maintained for the pre-determined duration, after which also the three-way valve 4 to this injection hole has been closed, and the injection pipe 3 has been disconnected such that it can be rinsed clean.

[0037] All injection holes with the exception of injection hole C have in this way been completed, and continued injection thus takes place only for injection hole C. It is an advantage that an exchange is made to another grouting mix for the continued injection, and Figure 12 shows the condition in which the injection process has been concluded. In the case of injection hole C, injection has been interrupted when the total volume injected into this injection hole has reached the pre-determined specified

maximum permitted injection volume, 600 litres. The injection pipe 3 has been disconnected for also this injection hole and has been rinsed clean. Since the complete injection process has now been completed, all three-way valves 4 in the system have been opened, as is made clear by the fact that the circles lack X symbols, and thus not only the pipelines 5 and injection pipes 3 but also the distribution pipe 2 can be rinsed clean with water that is supplied to the three-way valves 4 from the water line 6.

[0038] In the process that has been described above the simultaneous injection into seven injection holes A-G has been described: it is, however, obvious that the equipment can be designed for the simultaneous injection into fewer than seven holes just as easily as it can be designed for injection into more than seven holes. It is more a question of what is practical. In the same way, equipment that has been designed for injection into, for example, seven holes simultaneously can be used also for injection into fewer holes, through defining during the programming of the control unit 11 how many holes are to be injected, in which case only the three-way valves 4 for the programmed holes are opened in order to allow grout to pass.

[0039] With the method and arrangement according to the invention, thus, a continuous and simultaneous measurement of flow and pressure to each one of the holes that is being injected takes place during the injection, and the method and arrangement are controlled such that pre-determined criteria for the injection are reached for each one of the injection holes.

[0040] With the present invention, in which the valves are completely closed after an injection hole has been filled, wear of the valves is significantly reduced, and through the water being rinsed through the valve and also onwards through injection pipe, which has been disconnected.

[0041] As a consequence of the successive closing of the valves, as the injection holes become successively completed, also the injection capacity of the pump can be fully exploited for the injection of the holes that have not yet been completed. In this way the total injection duration is reduced, since the capacity of the pump can be exploited to fill holes and not, as is the case in the document referred to above, needing to be partially exploited to circulate injection material. This also increases the efficiency of the method and arrangement according to the invention.

[0042] With the present invention, which has an integrated system for rinsing clean, a method and an arrangement is obtained that are very efficient, and that allow also a rapid and simple rinsing clean also of the distribution pipe as soon as all injection holes have been filled.

Claims

1. A method for the injection of rock or soil material, whereby grout from a common supply pump (1) is simultaneously pumped through several injection pipes (3) to several injection holes, and where at least the pressure (10) and the injected volume (9) are monitored and individually measured with the aid of a control unit (11) for the supply to each one of the said injection holes (A-G), **characterised in that** the control unit (11), at the final conclusion of the injection of an injection hole (A-G), regulates a valve arrangement (4) such that no grout is fed any longer to the injection pipe (3) that leads to the relevant injection hole (A-G), and instead connects a water line (6) for the supply of water to the valve arrangement (4) and the injection pipe (3) in order that these be rinsed clean.

2. The method according to claim 1, **characterised in that** for each injection hole (A-G) an upper limiting value has been input for each one of pressure (10) and injected volume (9), wherein the control unit (11), in the event that the limiting value that has been input is reached, is arranged to interrupt the injection into the injection hole (A-G) for which the limiting value has been reached.

3. The method according to claim 1 or 2, **characterised in that** also the duration of injection into an injection hole is monitored for each one of the injection holes (A-G).

4. The method according to claim 2 or 3, **characterised in that**, when the limiting value for pressure is reached in an injection hole (A-G), this pressure is maintained in this injection hole by the control unit for the duration of a pre-determined pressurisation period.

5. The method according to any one of claims 2 to 4, **characterised in that** also an intermediate limiting value for the injected volume (9) is input, and where the control unit (11) is arranged to temporarily interrupt the injection for the injection hole (A-G) for which the intermediate limiting value has been reached without any one of the upper limiting values being reached.

6. An arrangement for the injection of rock or soil material, which arrangement is adapted such that it is able to inject several injection holes (A-G) at the same time through the arrangement comprising a pump (1) for grout connected to several injection pipes (3), each one of which is connected to an injection hole (A-G) for the simultaneous feed of grout to the injection holes (A-G) that are connected, and that the arrangement for each injection pipe (3) comprises also a pressure sensor (10) and a flow gauge (9) connected to a surveillance arrangement or control unit (11), **characterised in that** a water line (6)

is connected through a valve arrangement (4) for the supply of rinsing water to the injection pipe (3) when the control unit (11) has registered that injection into its injection hole (A-G) is complete and the injection pipe (3) has been disconnected from the relevant injection hole (A-G).

7. The arrangement according to claim 6, **characterised in that** the monitoring arrangement or control unit (11) is arranged to record for each one of the injection pipes (3) and injection holes (A-G) the pressure and injected volume of the grout that has been supplied, and an upper limiting value has been input to the control unit (11) for each one of pressure and injected volume, and which control unit (11), in the event that the limiting value that has been input is reached, is arranged to interrupt the injection into the injection hole (A-G) for which the limiting value has been reached and to define injection into the injection hole (A-G) as completed.

8. The arrangement according to claim 7, **characterised in that** the monitoring arrangement or control unit comprises also a timer in order to record the duration during which grout is supplied through the injection pipe (3) to the injection hole (A-G), **in that** an upper limiting value for the permitted injection duration has been input into the control unit for each one of the injection holes (A-G), and **in that** the control unit is arranged to interrupt the injection for the injection hole for which the limiting value for duration has been reached without the limiting values for pressure and volume having been reached.

9. The arrangement according to claim 8, **characterised in that** the pump (1) is arranged to feed grout to the injection pipes (3) through a distribution pipe (2), and **in that** each injection pipe (3) is joined to the distribution pipe (2) through the valve arrangement (4) that is controlled by the control unit (11) such that it is possible to permit or interrupt the injection through each one of the injection pipes.

10. The arrangement according to any one of claims 6-9, **characterised in that** the valve arrangement (4) is a three-way valve that is arranged also to be able to connect the water line (6) to the distribution pipe (2) in order to supply rinsing water to this.

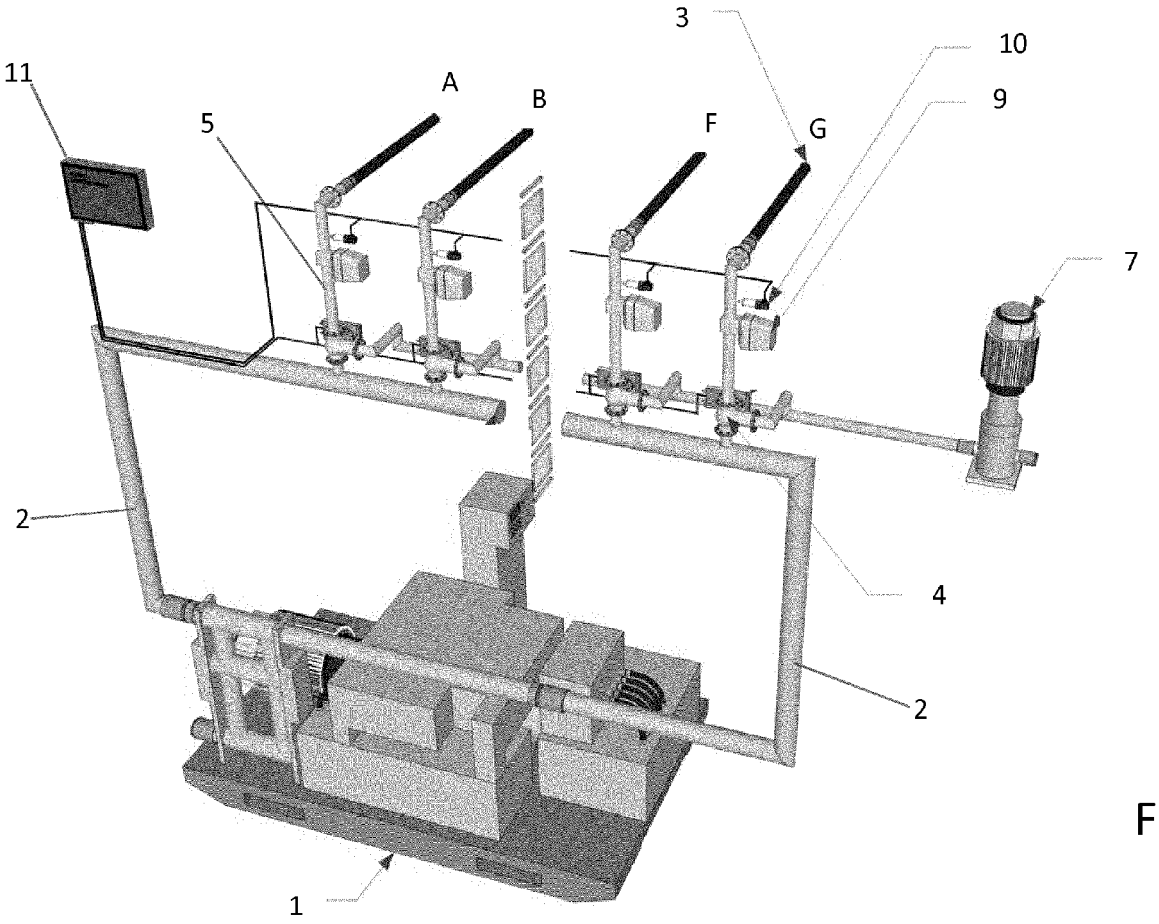

Fig. 1

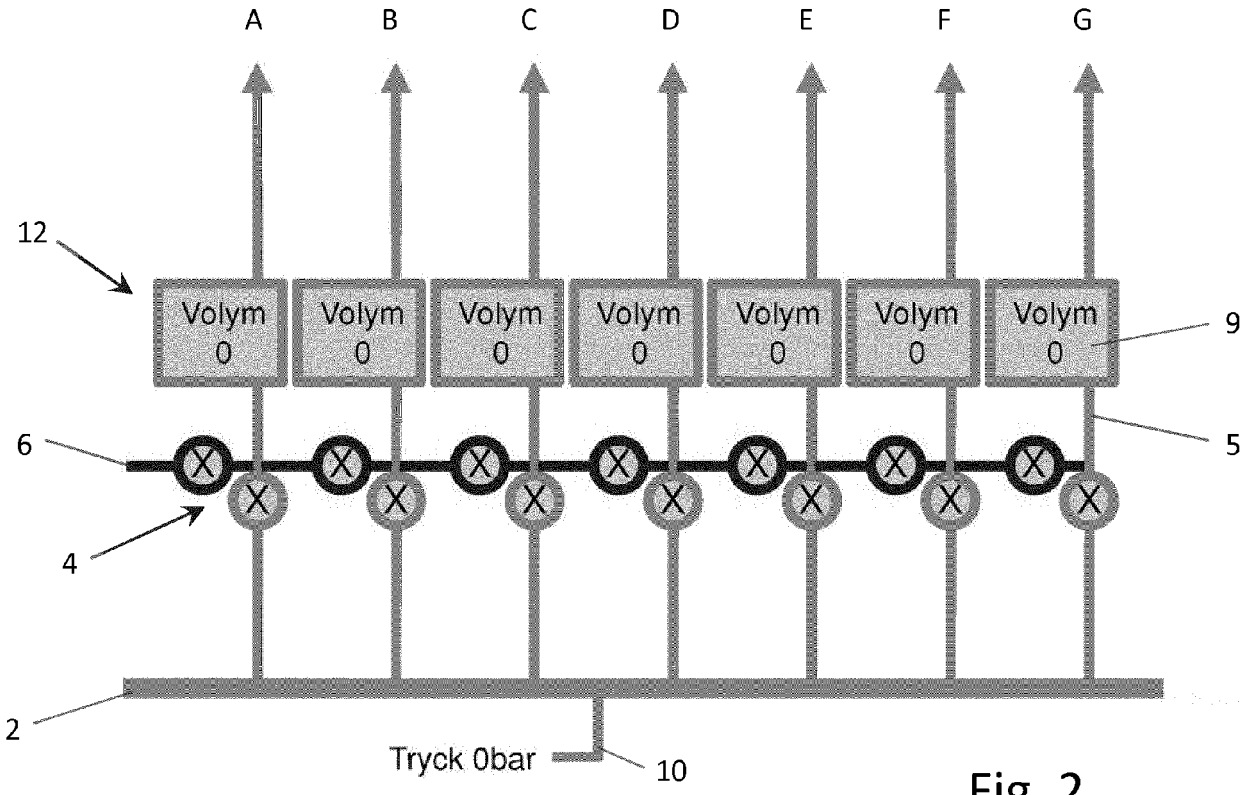
A
B
C
D
E
F
G
12
Volym 0
Volym 0
Volym 0
Volym 0
Volym 0
Volym 0
Volym 0
9
6
5
4
2
Tryck 0bar
10

Fig. 2

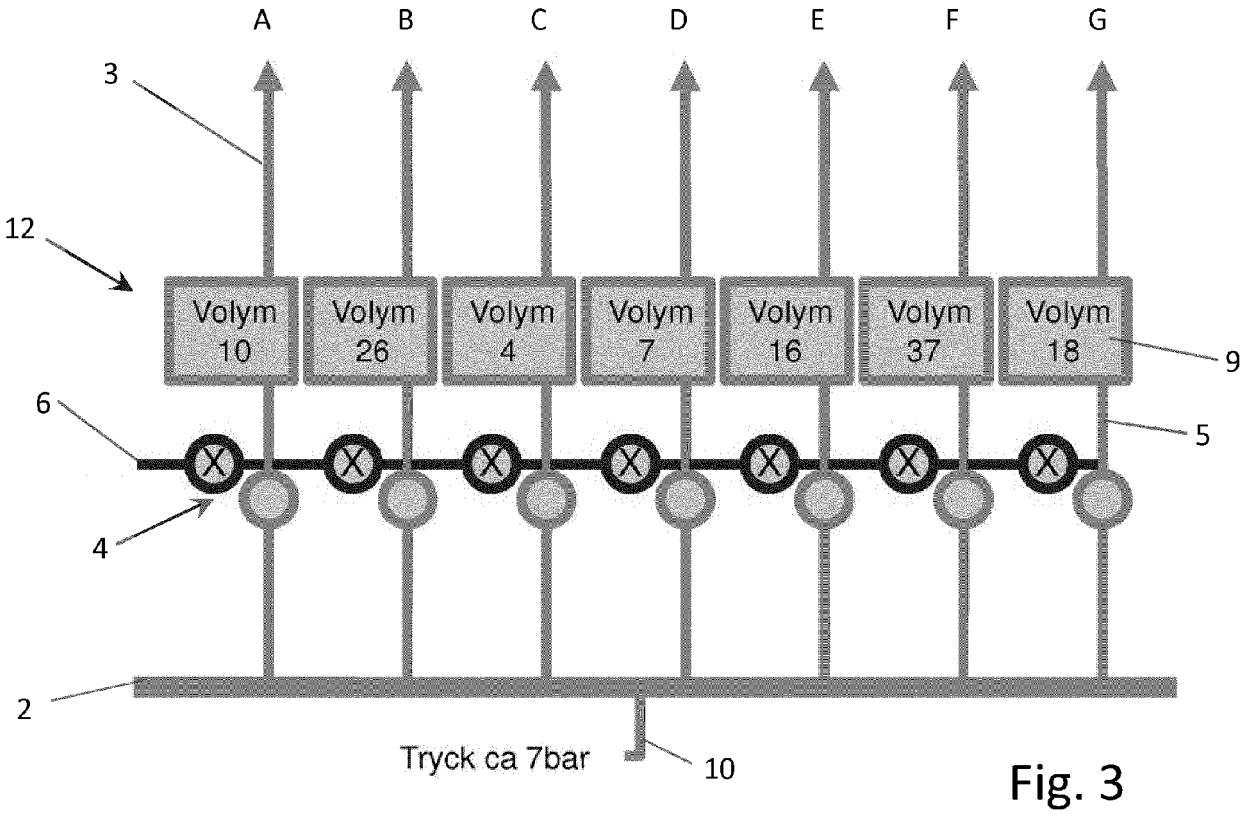
A
B
C
D
E
F
G
3
12
Volym 10
Volym 26
Volym 4
Volym 7
Volym 16
Volym 37
Volym 18
9
6
5
4
2
Tryck ca 7bar
10

Fig. 3

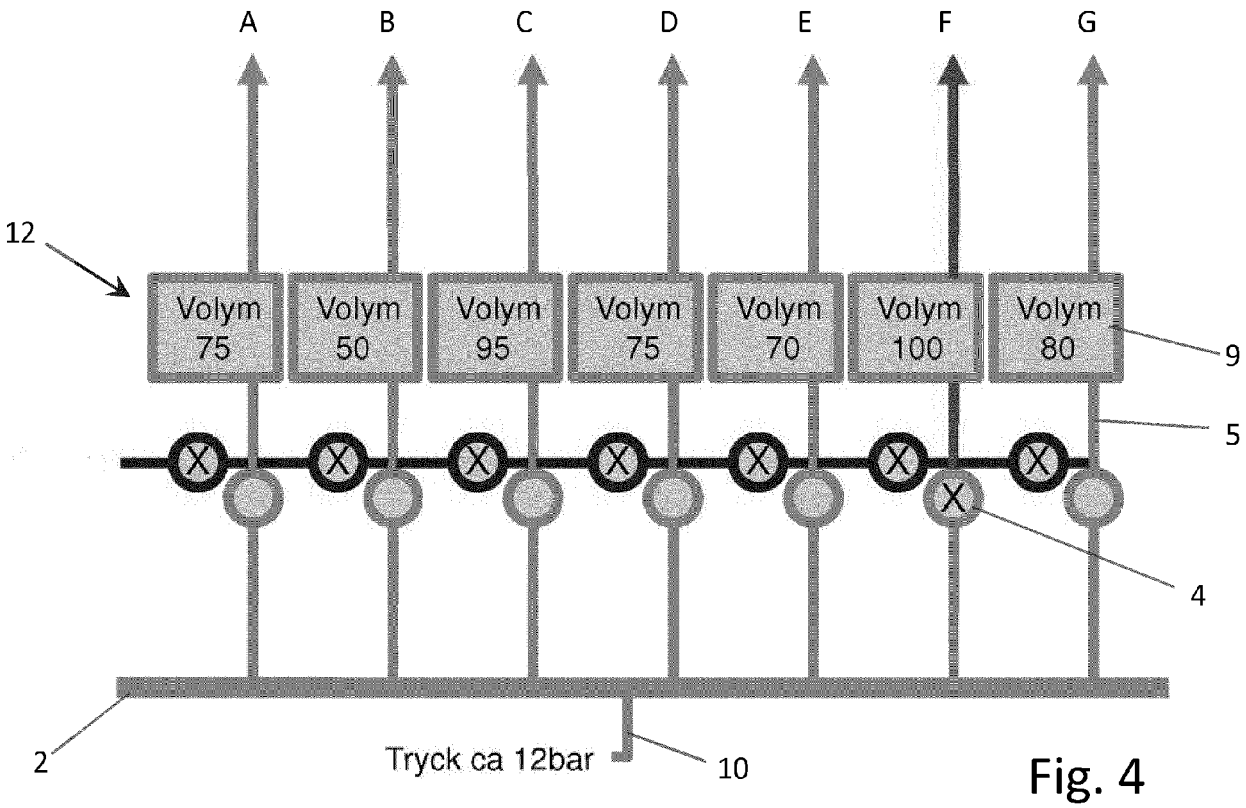
A
B
C
D
E
F
G
12
Volym 75
Volym 50
Volym 95
Volym 75
Volym 70
Volym 100
Volym 80
9
5
4
2
Tryck ca 12bar
10

Fig. 4

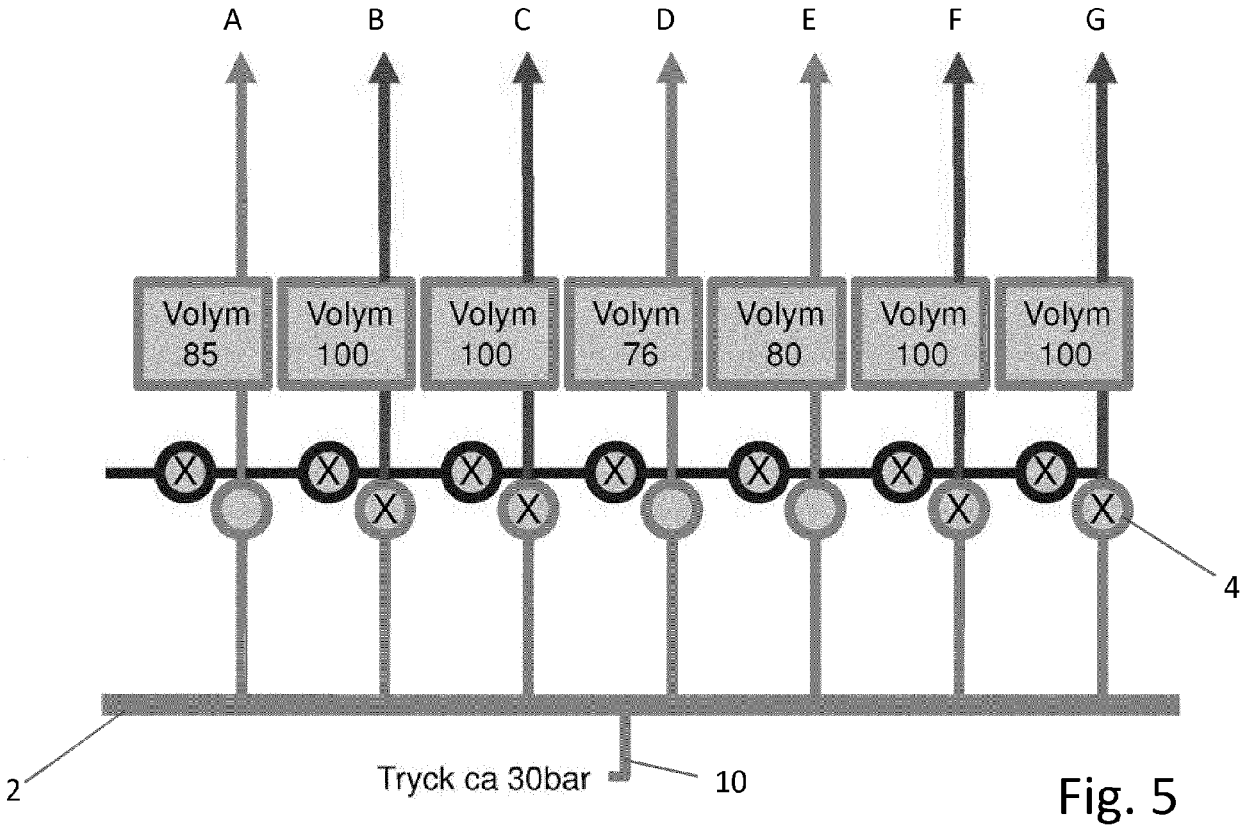
A
B
C
D
E
F
G
Volym 85
Volym 100
Volym 100
Volym 76
Volym 80
Volym 100
Volym 100
4
2
Tryck ca 30bar
10

Fig. 5

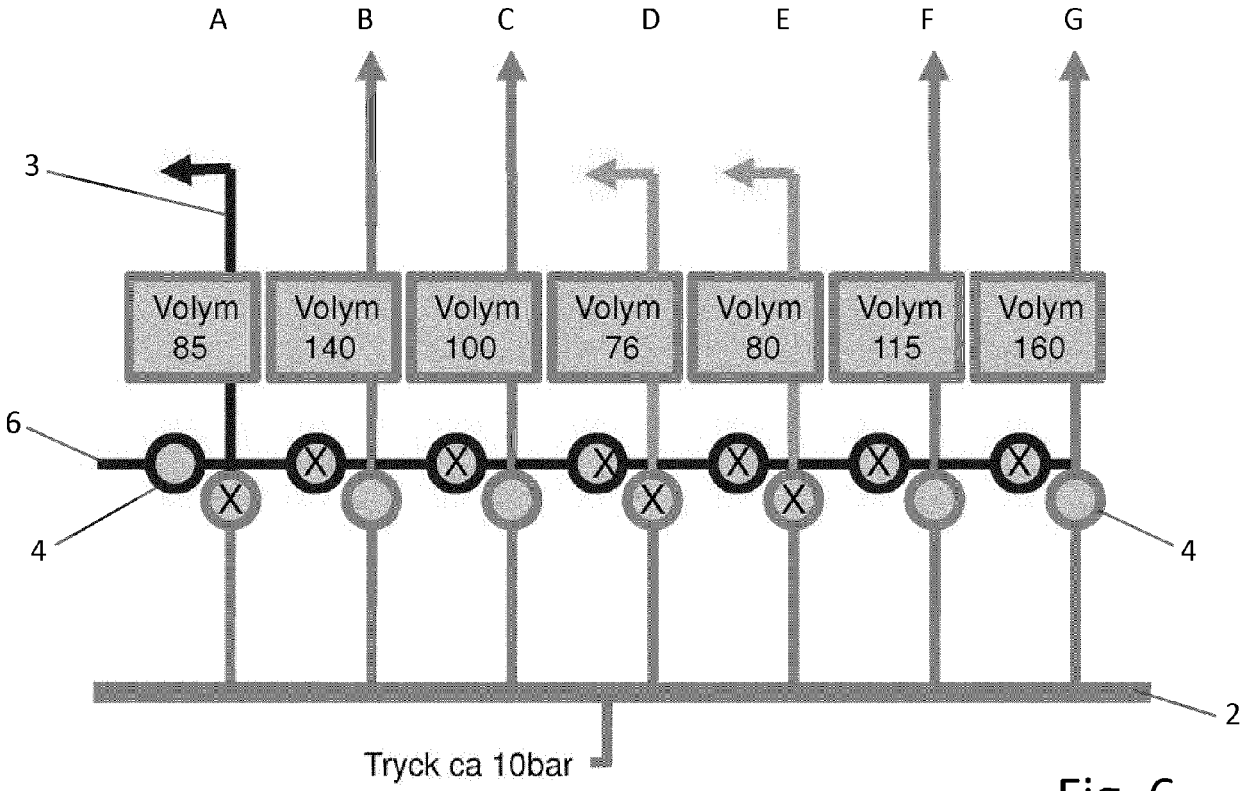
A
B
C
D
E
F
G
3
Volym 85
Volym 140
Volym 100
Volym 76
Volym 80
Volym 115
Volym 160
6
4
4
2
Tryck ca 10bar

Fig. 6

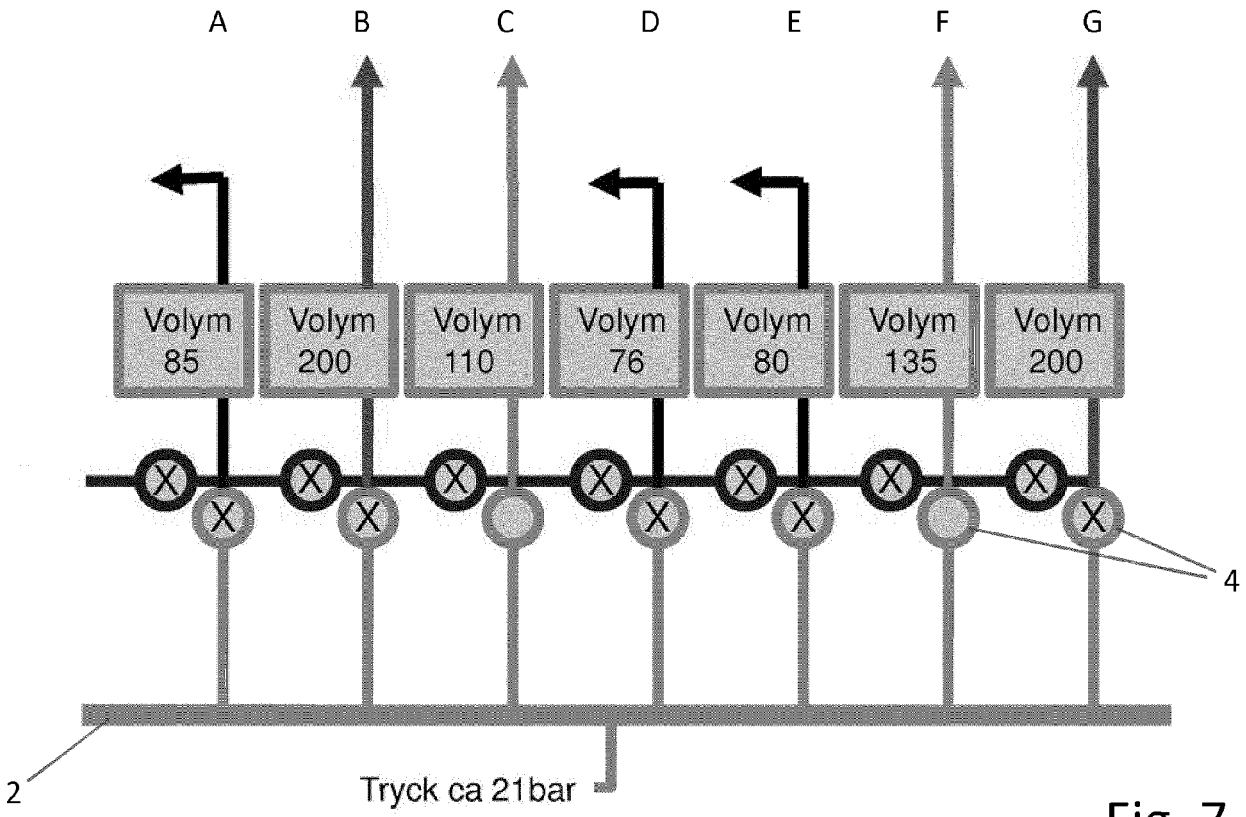
A
B
C
D
E
F
G
Volym 85
Volym 200
Volym 110
Volym 76
Volym 80
Volym 135
Volym 200
4
2
Tryck ca 21bar

Fig. 7

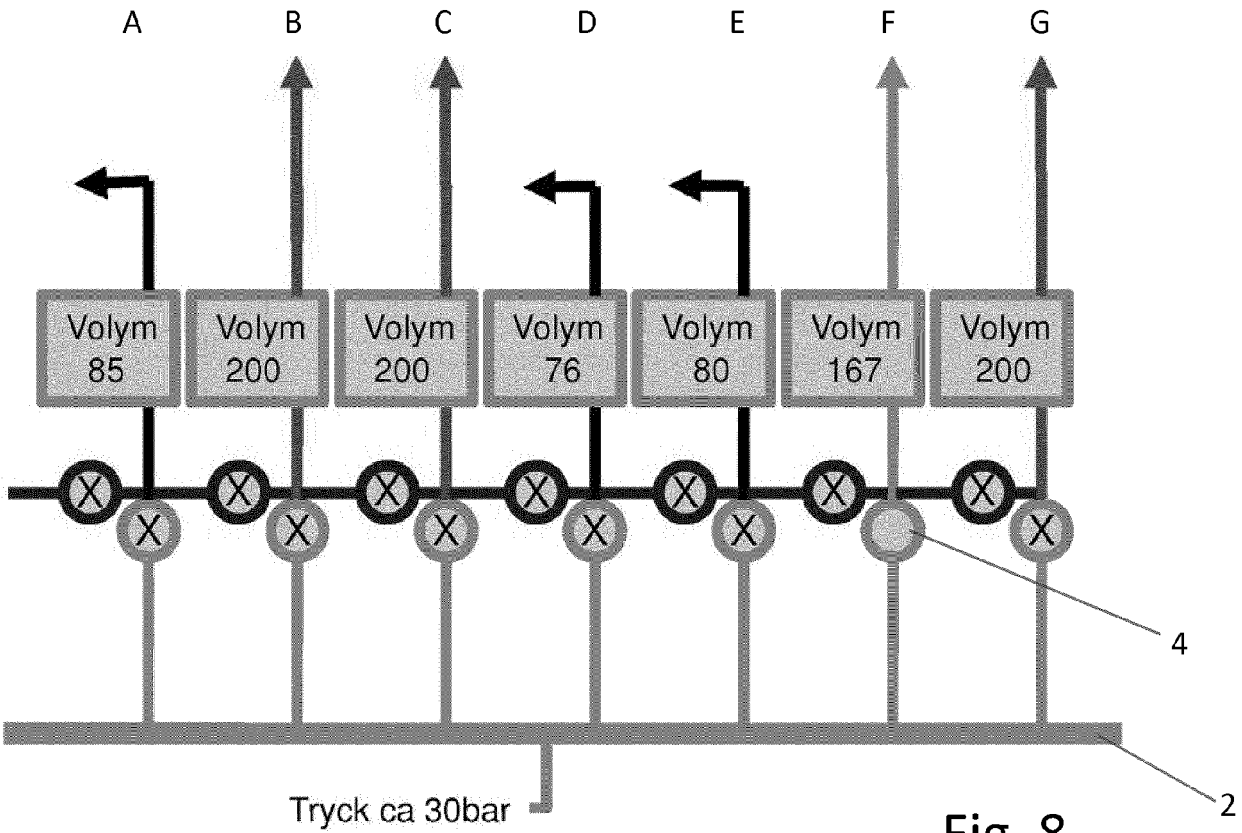
A
B
C
D
E
F
G
Volym 85
Volym 200
Volym 200
Volym 76
Volym 80
Volym 167
Volym 200
4
2
Tryck ca 30bar

Fig. 8

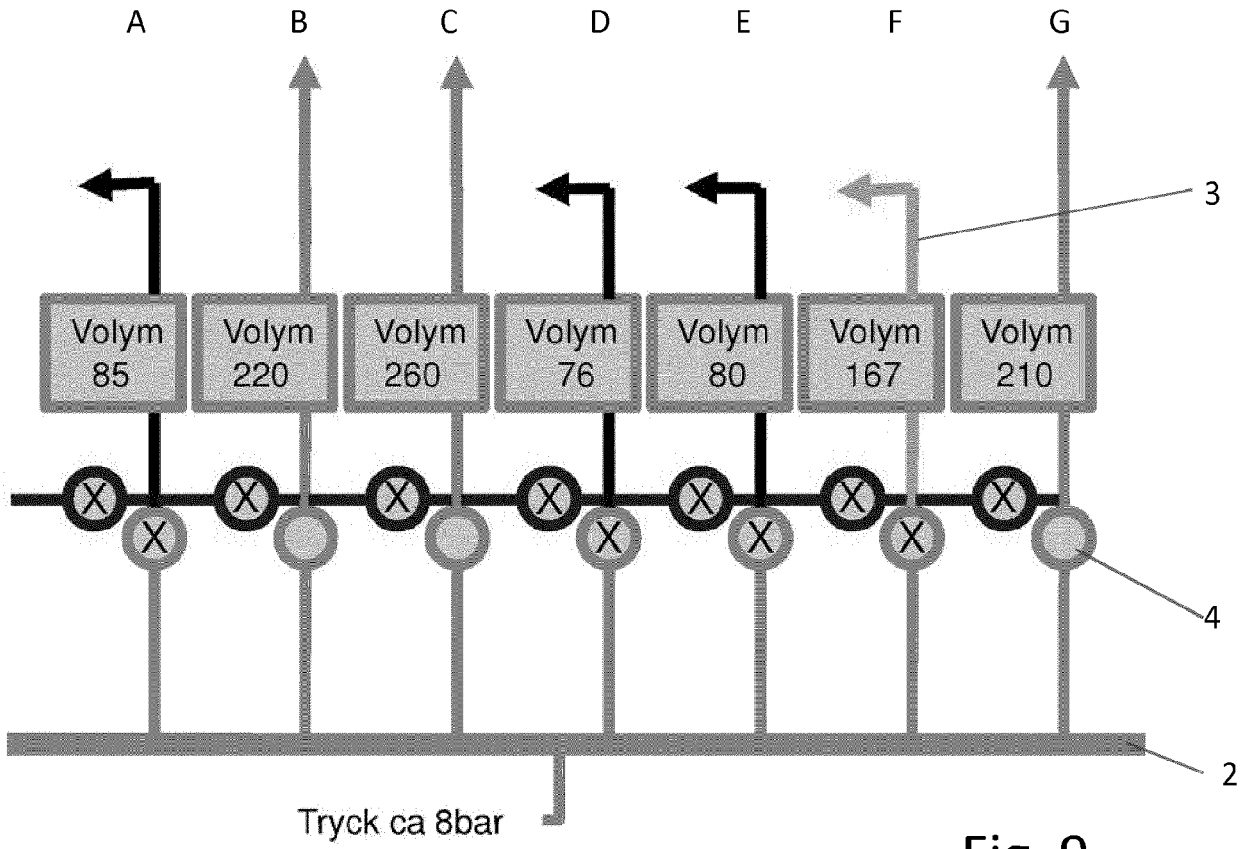
A
B
C
D
E
F
G
Volym 85
Volym 220
Volym 260
Volym 76
Volym 80
Volym 167
Volym 210
3
4
2
Tryck ca 8bar

Fig. 9

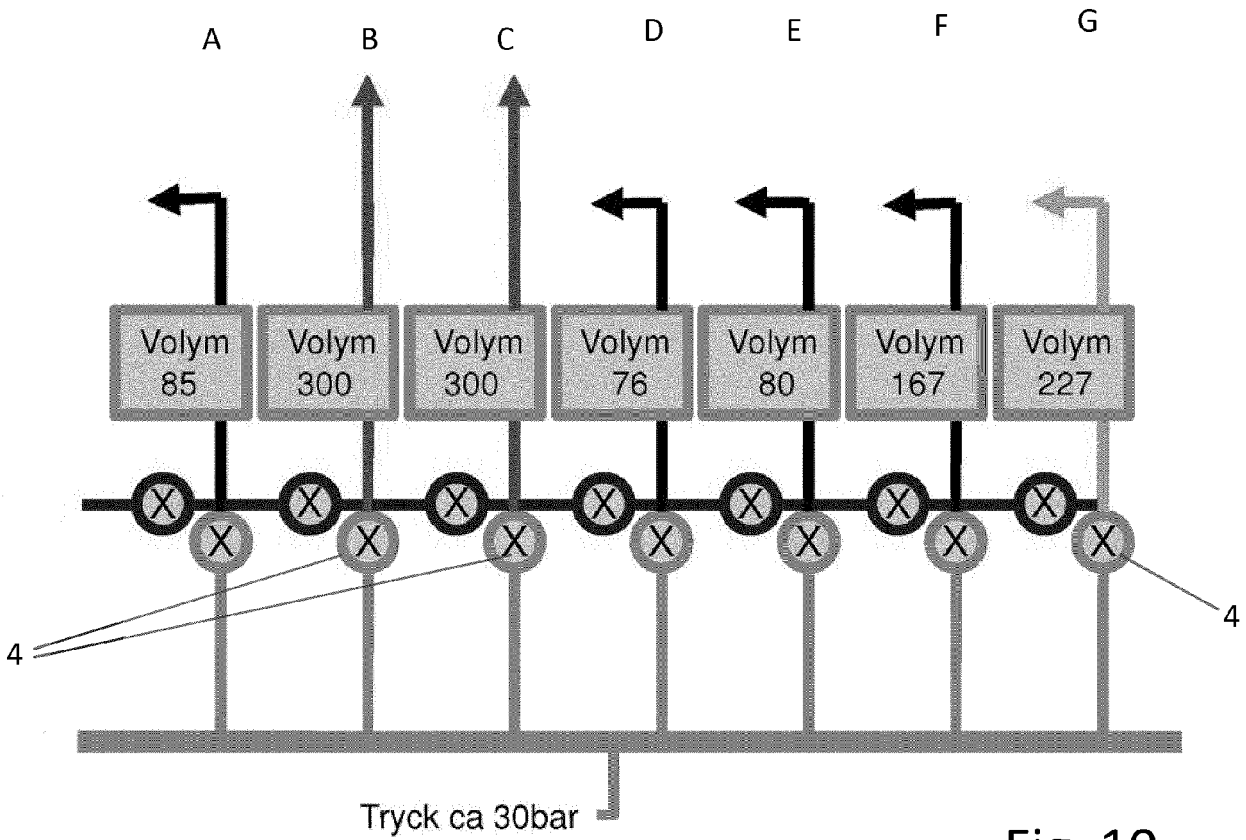
A
B
C
D
E
F
G
Volym 85
Volym 300
Volym 300
Volym 76
Volym 80
Volym 167
Volym 227
4
4
Tryck ca 30bar

Fig. 10

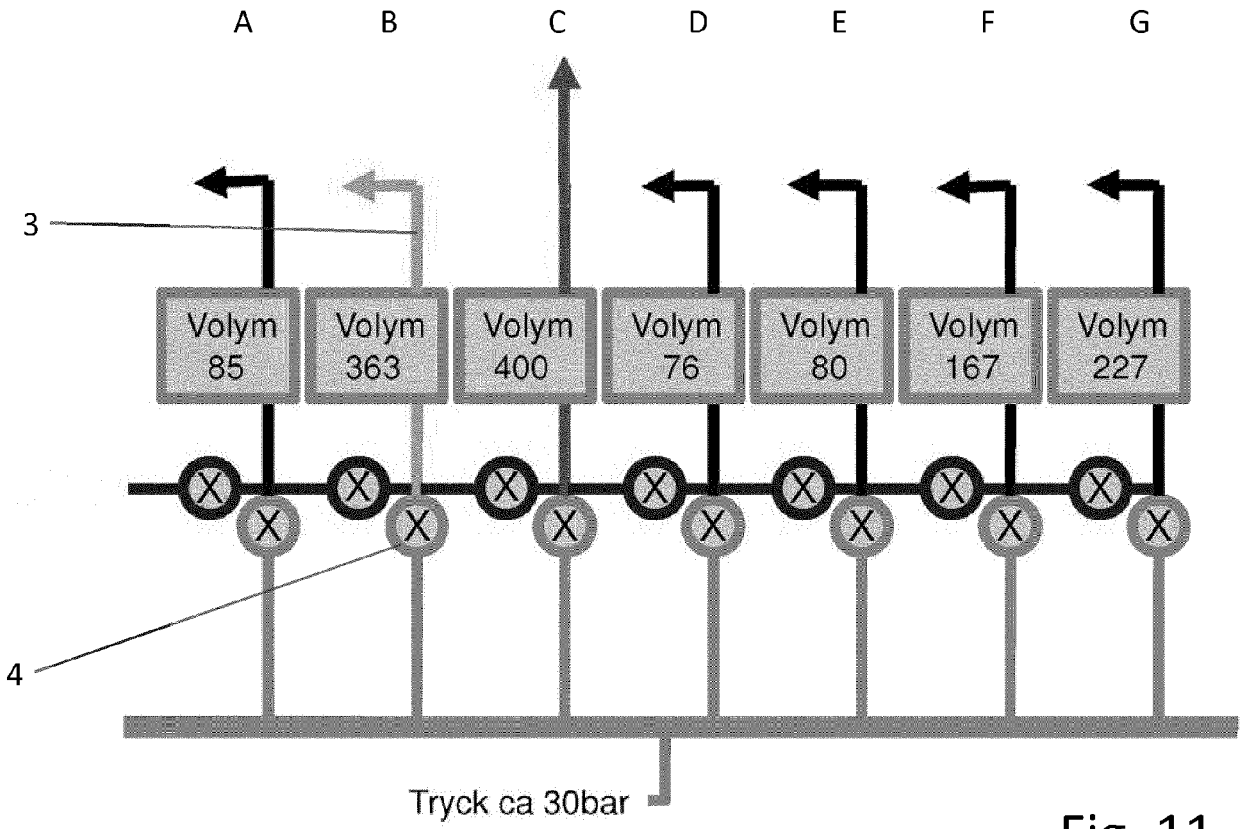
A
B
C
D
E
F
G
3
Volym 85
Volym 363
Volym 400
Volym 76
Volym 80
Volym 167
Volym 227
4
Tryck ca 30bar

Fig. 11

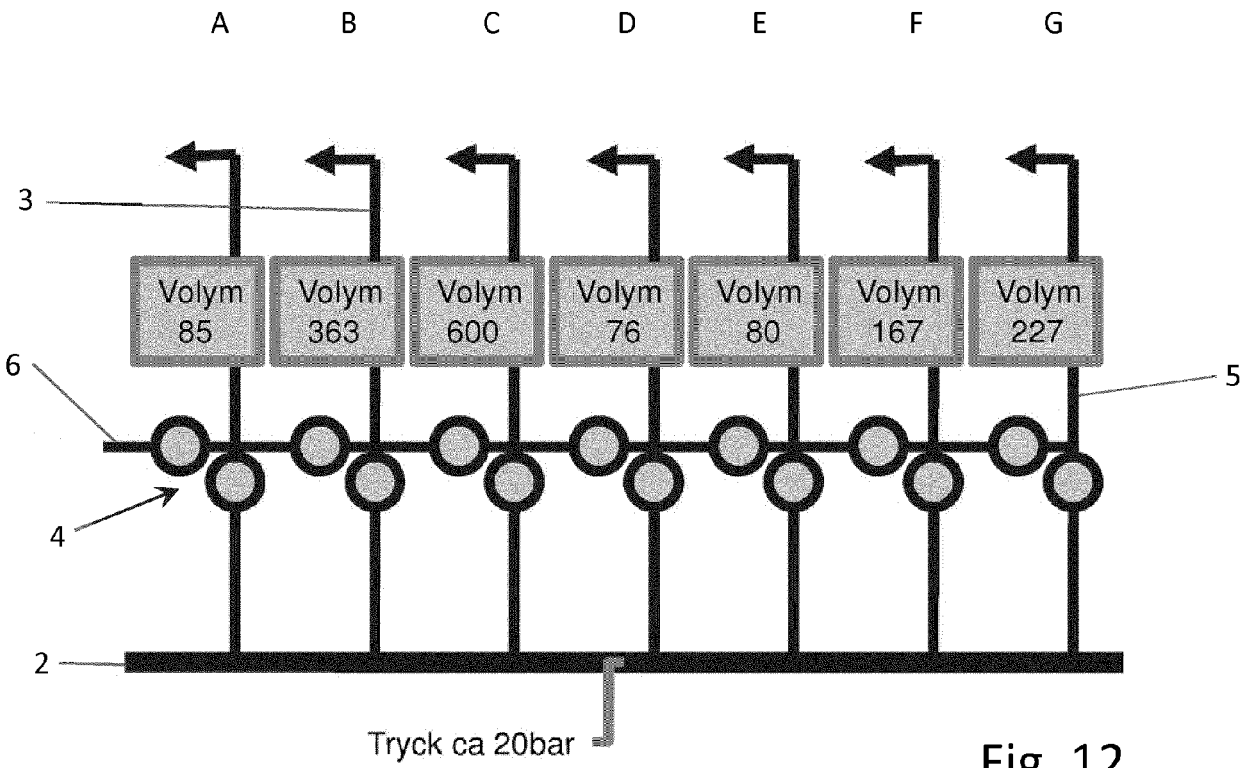
A
B
C
D
E
F
G
3
Volym 85
Volym 363
Volym 600
Volym 76
Volym 80
Volym 167
Volym 227
6
5
4
2
Tryck ca 20bar

Fig. 12

Europäisches Patentamt
European Patent Office
Office européen des brevets

EUROPEAN SEARCH REPORT

Application Number
EP 16 20 6348

DOCUMENTS CONSIDERED TO BE RELEVANT

Category	Citation of document with indication, where appropriate, of relevant passages	Relevant to claim	CLASSIFICATION OF THE APPLICATION (IPC)
Y	FR 2 084 885 A5 (ATLAS COPCO AB) 17 December 1971 (1971-12-17) * page 1, lines 31-37; figures 1,2 * * page 3, lines 5-7 * * page 3, line 11 - page 4, line 3 * -----	1-10	INV. E21D9/00 E21D20/02
Y	FR 2 307 124 A1 (CAVALLIN CHRISTER [SE]) 5 November 1976 (1976-11-05) * page 5, line 3 - page 6, line 20; figures 1,2 * -----	1-10	
A	WO 2014/199337 A1 (SOCIET CONSOLIDAMENTI E FONDAZIONI S R L [IT]) 18 December 2014 (2014-12-18) * the whole document * -----	1-10	
			TECHNICAL FIELDS SEARCHED (IPC) E21D E21B E02D

The present search report has been drawn up for all claims

Place of search	Date of completion of the search	Examiner
Munich	2 May 2017	Simunec, Duro

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 16 20 6348

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.

02-05-2017

Patent document cited in search report	Publication date	Patent family member(s)	Publication date
FR 2084885 A5	17-12-1971	NONE	
FR 2307124 A1	05-11-1976	CH 609423 A5	28-02-1979
		FR 2307124 A1	05-11-1976
		IT 1059963 B	21-06-1982
		SE 407604 B	02-04-1979
WO 2014199337 A1	18-12-2014	EP 3008250 A1	20-04-2016
		US 2016145823 A1	26-05-2016
		WO 2014199337 A1	18-12-2014

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

- SE 407604 B **[0011]**