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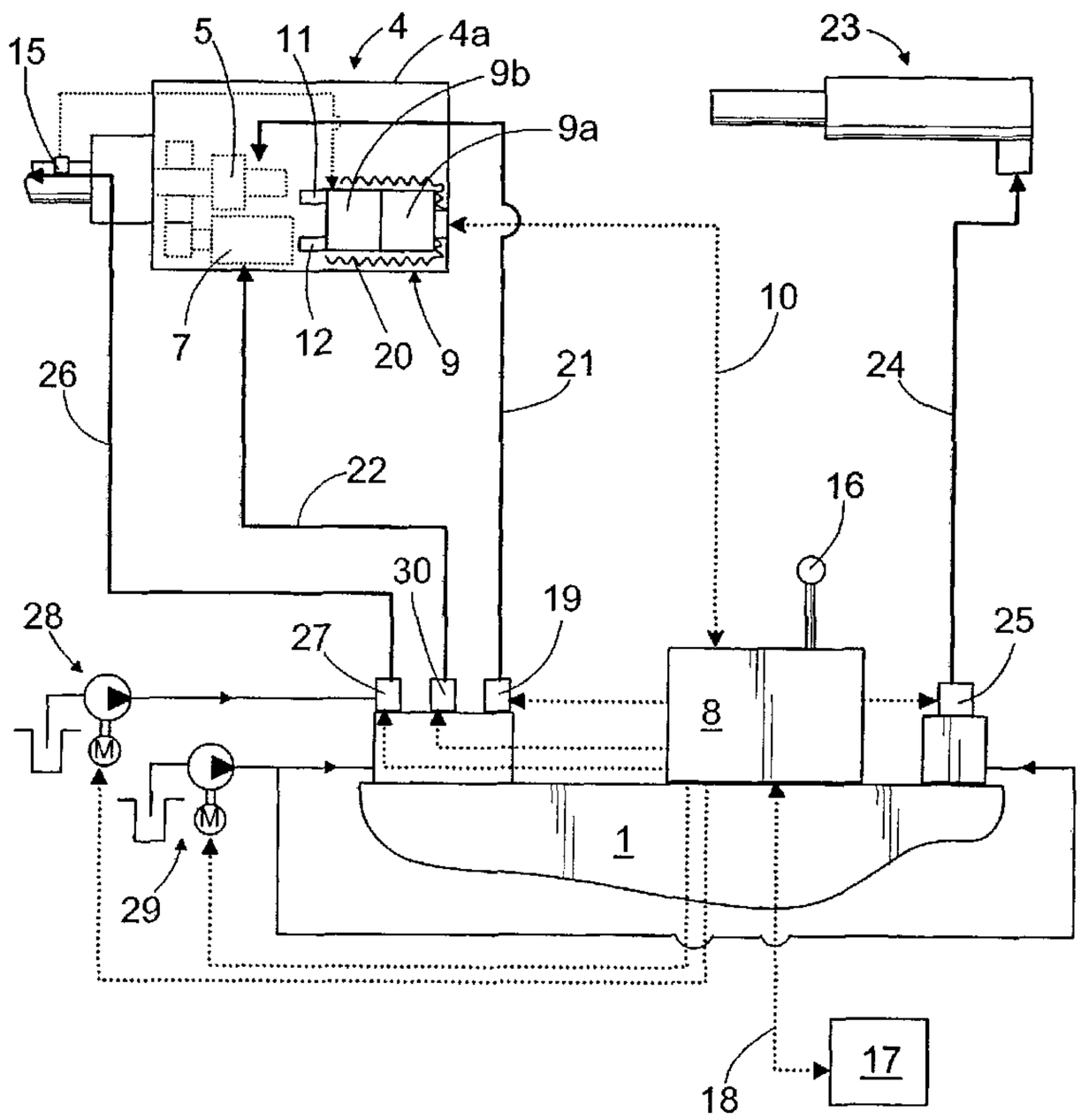
(54) Title: ROCK DRILLING APPARATUS AND ROCK BREAKING MACHINE



(57) Abrégé/Abstract:
The invention relates to a rock drilling apparatus and a rock breaking machine. The rock drilling apparatus comprises a first control unit (8) arranged on a carrier (1) and a second control unit (9) arranged to a rock drill (4). The first control unit (8) and the second control unit (9) communicate with each other by means of a first data communications link (10). The drill (4) has one or more sensors (11, 12, 15), the measuring results of which are processed in the second control unit (9) and only then transmitted to the first control unit (8) that controls actuators regulating the operation of the drill (4). Correspondingly, the rock breaking machine, such as a breaking hammer, comprises one or more sensors (11, 12, 15) and a control unit (9).

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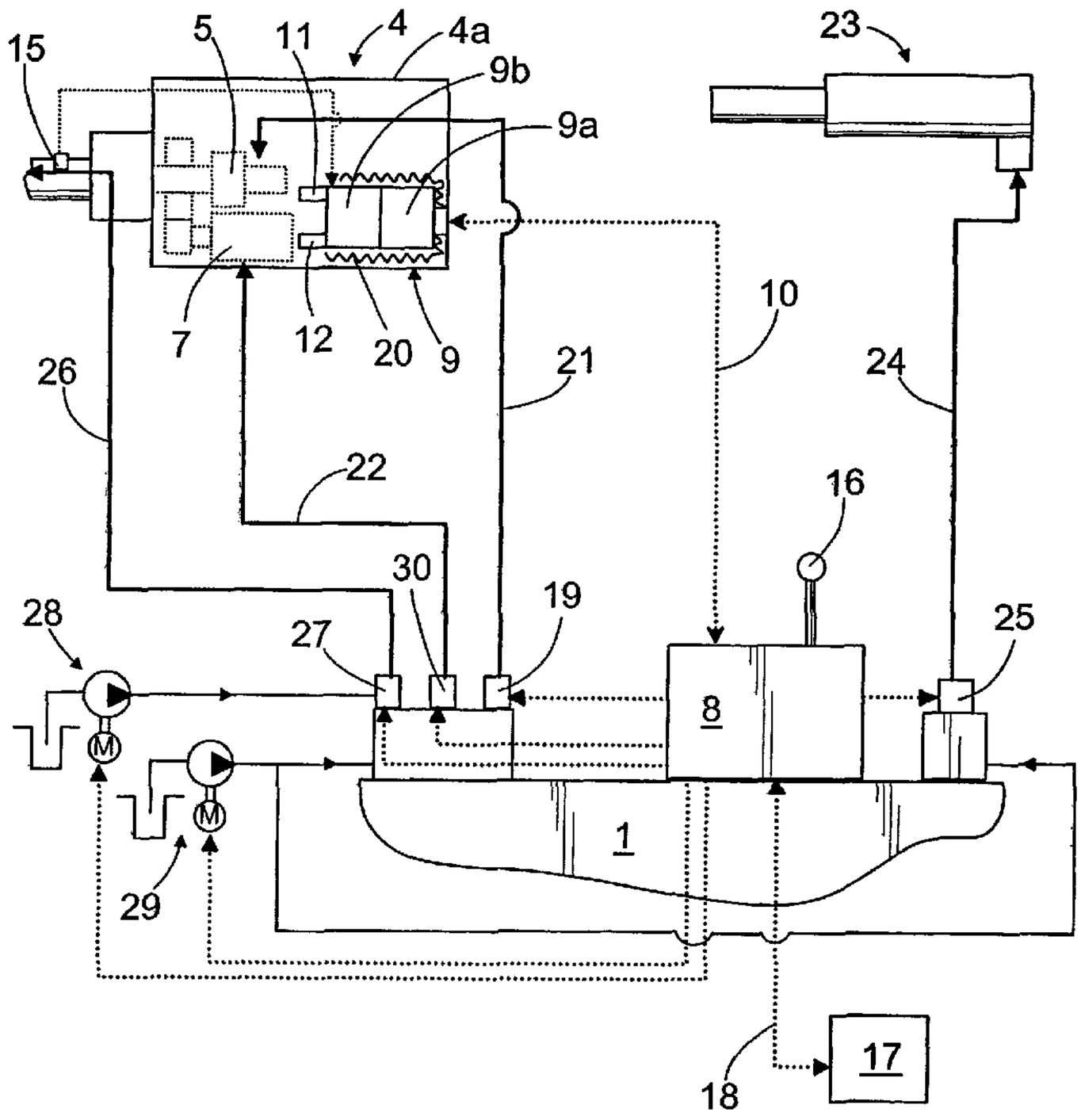

(57) Abstract: The invention relates to a rock drilling apparatus and a rock breaking machine. The rock drilling apparatus comprises a first control unit (8) arranged on a carrier (1) and a second control unit (9) arranged to a rock drill (4). The first control unit (8) and the second control unit (9) communicate with each other by means of a first data communications link (10). The drill (4) has one or more sensors (11, 12, 15), the measuring results of which are processed in the second control unit (9) and only then transmitted to the first control unit (8) that controls actuators regulating the operation of the drill (4). Correspondingly, the rock breaking machine, such as a breaking hammer, comprises one or more sensors (11, 12, 15) and a control unit (9).

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ROCK DRILLING APPARATUS AND ROCK BREAKING MACHINE

BACKGROUND OF THE INVENTION

[0001] The invention relates to a rock drilling apparatus comprising a carrier, feeding beam, rock drill movable in relation to the feeding beam and having a percussion device, one or more sensors arranged to the rock drill to monitor the operation of the rock drill, and further at least one first control unit arranged on the carrier of the rock drilling apparatus to control the operation of the rock drill on the basis of measuring information received from the sensors.

[0002] The invention further relates to a rock breaking machine comprising a body, percussion device arranged inside the body to generate impact pulses to a tool connectable to the rock breaking machine, and one or more sensors arranged to monitor the operation of the apparatus.

[0003] In prior art rock drilling apparatuses, the operation of the rock drill is controlled by a control unit arranged on the carrier of the rock drilling apparatus typically on a control deck. It is further known to equip a rock drill with one or more sensors to monitor the operation of the drill during use. Information received from the sensors is transmitted as such over a one-way channel to the control unit on the carrier of the rock drilling apparatus, which on the basis of the measuring information and parameters entered into the control unit forms the control commands required for drilling control. A rock drill is usually hydraulic, which means that in practice it is controlled by adjusting valves arranged in hydraulic channels leading to the rock drill. Normally, the valves are on the carrier. A drawback of the known rock drilling apparatuses is that the control unit is far away from the rock drill. This means that the relatively weak measuring signal received from the sensors arranged in the drill is easily disturbed, which reduces measuring accuracy. Thus, it is difficult to control the drill accurately on the basis of the received measuring information. Some measurements are not even worth making due to the long distance between the sensors and the control unit.

BRIEF DESCRIPTION OF THE INVENTION

[0004] It is an object of the present invention to provide a novel and improved rock drilling apparatus and rock breaking machine.

[0005] The rock drilling apparatus of the invention is characterized in that the rock drilling apparatus comprises a second control unit arranged to the rock drill and a data communications link between the first control unit and

the second control unit for transmitting information between the control units, that the sensors monitoring the operation of the rock drill are connected to transmit measuring information to the second control unit, that the second control unit comprises a memory unit for storing basic settings for the drill and a processing unit for calculating parameters describing the operating state of the rock drill on the basis of said basic settings and measuring information, and that the first control unit is arranged to control the operation of the rock drill on the basis of the parameters received from the second control unit and instructions given to the first control unit.

[0006] Further, the rock breaking machine of the invention is characterized in that the rock breaking machine has a control unit, that said sensors are arranged to transmit measuring information to the control unit, that the control unit comprises a memory unit for storing basic settings for the rock breaking machine and further a processing unit that is, during operation, arranged to form parameters describing the operating state of the rock breaking machine on the basis of the basic settings and measuring information, and that the control unit comprises an connection to a data communications link that enables communication between the control unit and at least one unit external to the rock breaking machine.

[0007] The essential idea of the invention is that for controlling drilling, a first control unit is arranged on the carrier of the rock drilling apparatus and a second control unit is also arranged to the rock drill. Said control units communicate with each other using a data communications link arranged between them. One or more sensors are arranged to the drill to monitor the operation of the drill during drilling. Measuring results received from the sensors are transmitted to the second control unit that comprises a memory unit and processing unit. The basic settings of the drill can be stored in the memory unit. The processing unit is in turn arranged to calculate parameters describing the operating state of the drill on the basis of the measuring information received from the sensors and the basic settings stored in the memory unit. From the second control unit, the parameters are transmitted to the first control unit arranged on the carrier of the drilling apparatus that controls the actuators affecting the operation of the drill, such as valves or electric regulating elements, on the basis of the parameters and control commands given to the second control unit so as to achieve the desired operating state of the drill. Because the prevailing operating state of the drill is defined already in the drill,

the control unit arranged on the carrier can be a relatively simple one. At its simplest, the first control unit is a control element, by means of which the desired drilling values are entered into the control system. Because the equipment for defining the operating state of an individual drill, i.e. the sensors and second control unit, is arranged to the drill, the replacement of the entire drill or a later modification of the original drill is simple and does not cause difficult changes to the control system in the rock drilling apparatus.

[0008] The essential idea of an embodiment of the invention is that the second control unit is arranged inside the rock drill where it is protected from dents and ambient conditions. In addition, at least some of the sensors are integrated as part of the control unit so that the control unit and sensors form together a compact entity. Even weak measuring signal received from the sensors can then be received by the second control unit. All in all, the measuring results can thus be made more accurate, which enables an accurate control of the drill. Further, this type of control unit is easy to replace, if the control of the drill later requires updating.

[0009] The essential idea of an embodiment of the invention is that between the first and second control units, there is a CAN (Controller Area Network) bus that also enables a versatile monitoring of the drill. Through monitoring, detected and starting defects can efficiently be communicated to the user. The CAN bus has proven a reliable solution in demanding conditions.

[0010] The essential idea of an embodiment of the invention is that the second control unit comprises an identifier that the first control unit is arranged to read automatically, whereby the drill connected to the rock drilling apparatus is always explicitly identified. This facilitates the possible replacement of the drill.

BRIEF DESCRIPTION OF THE FIGURES

[0011] The invention is described in more detail in the attached drawings, in which

Figure 1 is a schematic side view of a rock drilling apparatus of the invention,

Figure 2 is a schematic side view of a rock drill of the invention, and

Figure 3 is a schematic representation of a control system of the invention.

[0012] For the sake of clarity, the invention is shown simplified in the figures. The same reference numerals are used for similar parts.

DETAILED DESCRIPTION OF THE INVENTION

[0013] The rock drilling apparatus shown in Figure 1 comprises a movable carrier 1, a boom 2 arranged movable in relation to the carrier, and a feeding beam 3 arranged to the free end of the boom. In some cases, the feeding beam 3 can be arranged directly on the carrier 1. A rock drill 4 can be moved in relation to the feeding beam 3 by means of suitable actuators.

[0014] Figure 2 shows a rock drill 4 comprising a percussion device 5 for providing impact pulses to a tool 6 connected to the drill. Further, the rock drill usually comprises a rotating device 7 for rotating the tool 6 around its longitudinal axis. Because the general structure and operation of a rock drilling apparatus and rock drill are obvious to a person skilled in the art, they need not be described in more detail in this application.

[0015] Figure 3 shows the principle of a control system of the invention. The control system comprises a first control unit 8 arranged on the carrier 1 of the rock drilling apparatus. Further, the system comprises a second control unit 9 arranged to the rock drill 4 or some other rock breaking machine. In this context, a rock breaking machine refers not only to a drill, but also to any other apparatus comprising a percussion device, such as a breaking hammer. Between the first control unit 8 and the second control unit 9, there is a data communications link 10, preferably a CAN (Controller Area Network) bus, enabling bi-directional data communication between the control units 8, 9. This way, the control units 8 and 9 can communicate and exchange information with each other. Other suitable fixed data transmission channels can also be applied. In some cases even a wireless link between the control units is possible.

[0016] The second control unit 9 is preferably arranged inside the body 4a of the rock drill, where it is protected from the ambient conditions and dents. Due to severe operating conditions, it is advantageous to use surface-mounted devices in the electronic circuits of the control unit 9, because they endure vibration relatively well. The harmful effect of vibration can further be reduced by arranging the entire control unit 9 or at least its most vulnerable components inside a suitable elastic mass 20. The construction and its placement inside the drill should also be arranged in such a manner that the control unit 9 does not overheat during operation.

[0017] The second control unit 9 comprises a memory unit 9a and processing unit 9b. The individual basic settings of each drill type can be stored in the memory unit 9a. The basic settings depend on the construction

and size category of the drill. The basic settings include information on the impact pressure used in the drill, volume flow of the rotating motor, volume flow of flushing, feeding pressure, etc. The processing unit 9b comprises a computer, programmable logic or the like able to process the entered information. Further, one or more sensors 11, 12 are preferably integrated to the second control unit 9. In this case, sensor 11 is arranged to monitor the operation of the percussion device 5 and sensor 12 is arranged to monitor the operation of the rotating device 7. Further, measuring information is transmitted to the second control unit 9 from a separate sensor 15 that is arranged to monitor the feeding of flushing medium.

[0018] Control commands and a possible drilling plan is entered into the first control unit. Drillings plans can be entered manually into the first control unit 8 by using a user interface, such as controller 16, in it, or they can be loaded from an external unit, such as computer or diskette. Further, the first control unit 8 can be connected to a third control unit 17 external to the rock drilling apparatus 1 through a second data communications link 18. Such a solution can be applied to the control of autonomous apparatuses, for instance, in which case the third control unit 17 can be arranged in a control room outside the mine, from which the control commands and drilling plans are delivered to the first control unit 8.

[0019] In a simplified manner, the control system operates in such a manner that the first control unit 8 informs the second control unit 9 on the basis of the instructions, i.e. the drilling plan and control commands, how the drill 4 should operate at each time. After the basic settings of the drill and the prevailing situation, i.e. operating state, have been taken into consideration, the second control unit 9 informs the first control unit 8 what external resources it needs to perform the required operation. It is thus a kind of feedback arrangement. In practice, the processing unit 9b of the second control unit 9 forms parameters that are transmitted to the first control unit 8 where the parameters are compared with the instructions entered into the first control unit 8. On the basis of the comparison, the first control unit 8 adjusts the actuators affecting the operation of the drill 4. In the solution shown in Figure 3, the first control unit 8 adjusts a first valve 19 that is arranged in a pressure medium channel 21 leading to the percussion device 5. Further, the first control unit 8 adjusts a second valve 30 that is arranged in a pressure medium channel 22 leading to the rotating device 7. A third valve 25 arranged in a channel 24 leading to a

feeding cylinder 25 and a fourth valve 27 arranged in a flushing medium channel 26 are adjusted correspondingly. Further, pumps 28 and 29 can also be adjusted. By adjusting the percussion device, rotating device, the feeding and flushing of the drill, for instance, the drill can be directed to operate exactly in the desired manner in each situation.

[0020] In known solutions, the control system of the rock drill is designed for one drill type only. A possible later modification of the drill or its replacement to a drill differing in power or other properties from the original assembly causes massive and expensive changes to the control system of the entire rock drilling apparatus. Instead, the solution of the invention enables the use of different drills, since the control system identifies the drill arranged in the rock drilling apparatus. The identification information may be stored in the basic settings of the second control unit that the first control unit can read through the data communications link. Alternatively, the second control unit can be equipped with a mechanical detector based on shorted circuits or the like. To facilitate the later replacement of the drill, the equipment mounted on the carrier of the rock drilling apparatus is preferably dimensioned in such a manner that it is suitable for drills of different sizes.

[0021] The drawings and the related description are only intended to illustrate the idea of the invention. The invention may vary in detail within the scope of the claims. Therefore, even though the figures and their description describe an invention for a rock drill, the invention can also be applied to other rock breaking machines comprising a percussion device, such as secondary breaking apparatuses. Further, it does not matter to the solution of the invention whether the percussion device is operated by pressure medium, electricity or in some other manner. For instance, in an electrically operated apparatus, electrical quantities are controlled instead of hydraulic valves and pumps.

CLAIMS

1. A rock drilling apparatus comprising a carrier (1), feeding beam (3), rock drill (4) movable in relation to the feeding beam (3) and having a percussion device (5), one or more sensors (11, 12, 15) arranged to the rock drill (4) to monitor the operation of the rock drill (4), and further at least one first control unit (8) arranged on the carrier (1) of the rock drilling apparatus to control the operation of the rock drill (4) on the basis of measuring information received from the sensors (11, 12, 15), **characterized** in that

the rock drilling apparatus comprises a second control unit (9) arranged to the rock drill (4) and a data communications link (10) between the first control unit (8) and the second control unit (9) for transmitting information between the control units (8, 9),

the sensors (11, 12, 15) monitoring the operation of the rock drill (4) are connected to transmit measuring information to the second control unit (9),

the second control unit (9) comprises a memory unit (9a) for storing basic settings for the drill and a processing unit (9b) for calculating parameters describing the operating state of the rock drill (4) on the basis of said basic settings and measuring information, and

the first control unit (8) is arranged to control the operation of the rock drill (4) on the basis of the parameters received from the second control unit (9) and instructions given to the first control unit (8).

2. A rock drilling apparatus as claimed in claim 1, **characterized** in that the second control unit (9) is arranged inside the body (4a) of the rock drill and that at least some of the sensors (11, 12) are integrated as part of the second control unit (9).

3. A rock drilling apparatus as claimed in claim 1 or 2, **characterized** in that the first data communications link (10) between the first control unit (8) and the second control unit (9) is a CAN bus.

4. A rock breaking machine comprising a body (4a), percussion device (5) arranged inside the body (4a) to generate impact pulses to a tool (6) connectable to the rock breaking machine, and one or more sensors (11, 12, 15) arranged to monitor the operation of the apparatus, **characterized** in that

the rock breaking machine has a control unit (9),

said sensors (11, 12, 15) are arranged to transmit measuring information to the control unit (9),

the control unit (9) comprises a memory unit (9a) for storing basic settings for the rock breaking machine and further a processing unit (9b) that is, during operation, arranged to form parameters describing the operating state of the rock breaking machine on the basis of the basic settings and measuring information, and

the control unit (9) comprises an connection to a data communications link (10) that enables communication between the control unit (9) and at least one unit external to the rock breaking machine for controlling the operation of the rock breaking machine so as to achieve the desired operating state of the rock breaking machine.

5. A rock breaking machine as claimed in claim 4, **characterized** in that the control unit (9) is arranged inside the body (4a) of the rock breaking machine and that at least some of the sensors (11, 12) are integrated as part of the control unit (9).

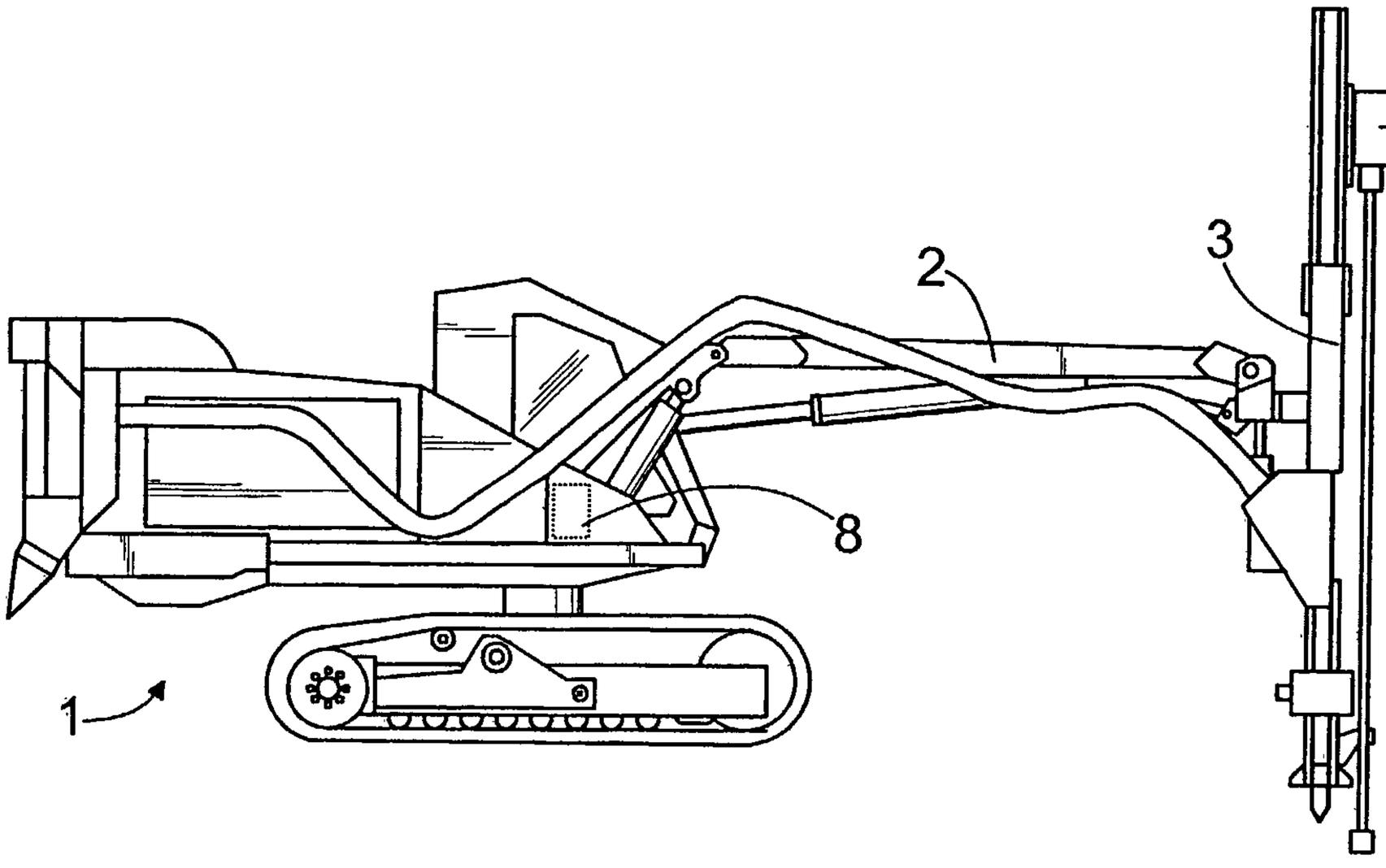

FIG. 1

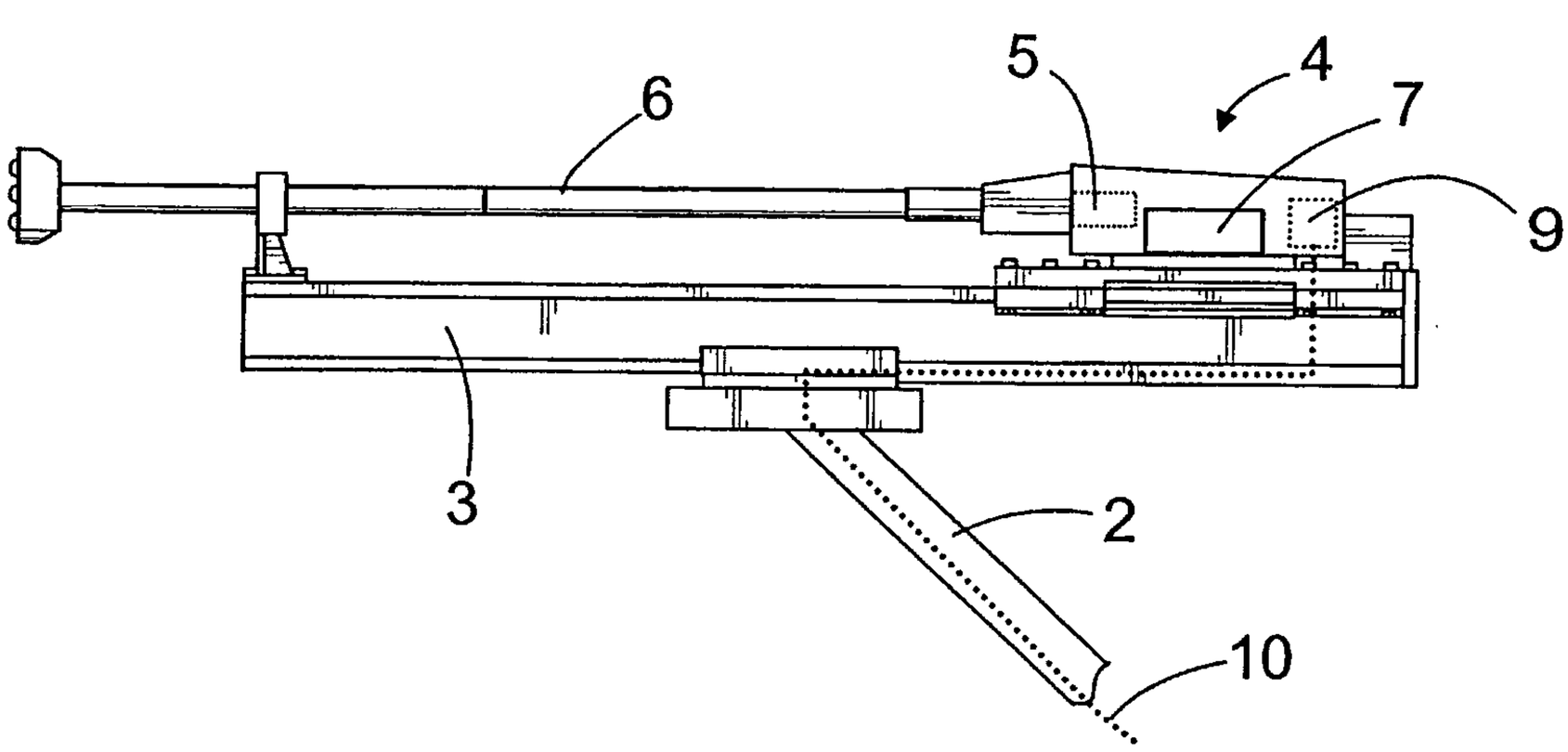

FIG. 2

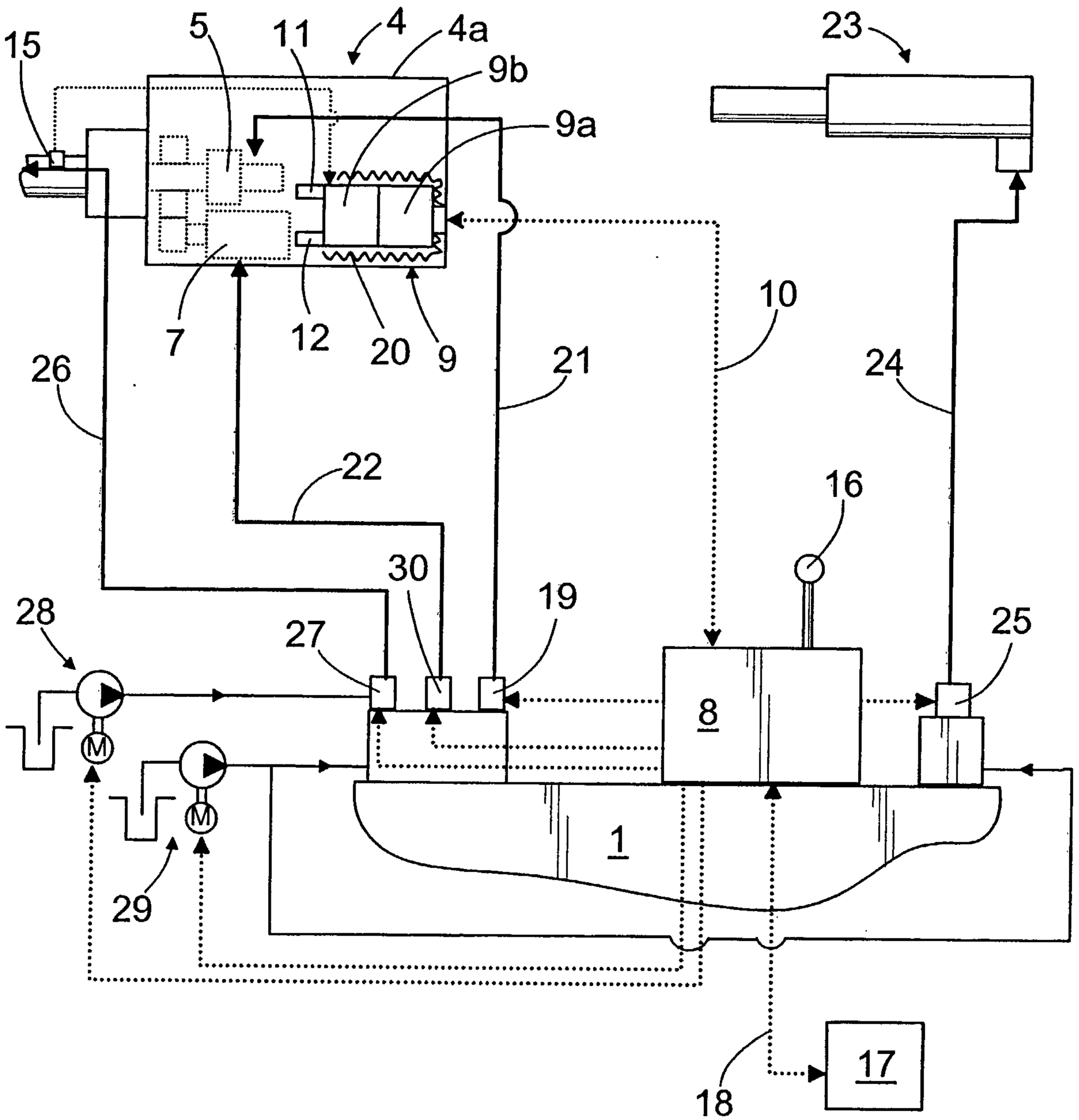
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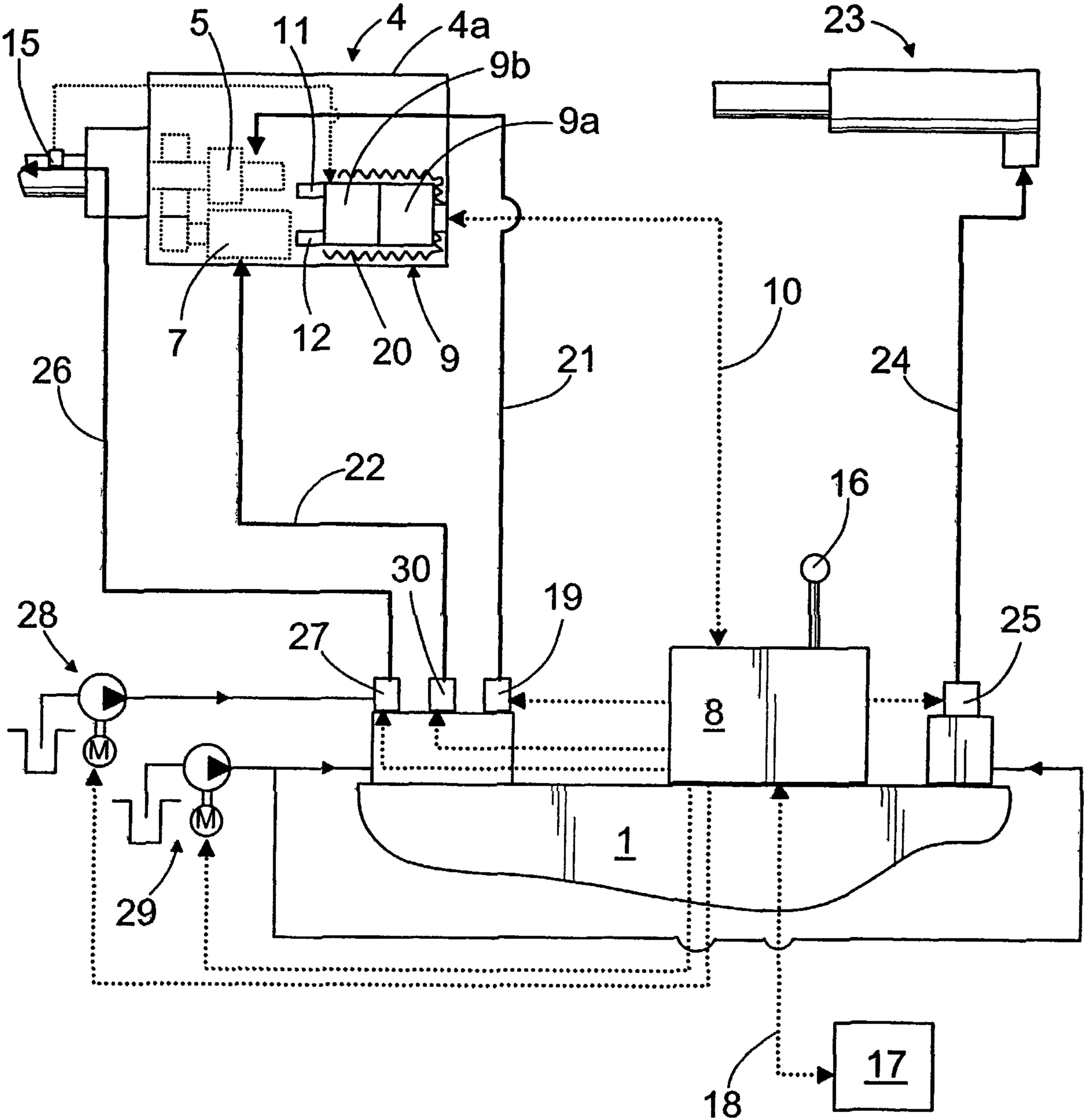
FIG. 3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