(19) Europäisches Patentamt
European Patent Office
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(11) EP 1 594 197 A1

(12) **EUROPEAN PATENT APPLICATION**

(43) Date of publication:
09.11.2005 Bulletin 2005/45

(51) Int Cl.[7]: **H01R 13/637**

(21) Application number: **05425288.7**

(22) Date of filing: **04.05.2005**

(84) Designated Contracting States:
AT BE BG CH CY CZ DE DK EE ES FI FR GB GR HU IE IS IT LI LT LU MC NL PL PT RO SE SI SK TR
Designated Extension States:
AL BA HR LV MK YU

(30) Priority: **07.05.2004 IT fi20040109**

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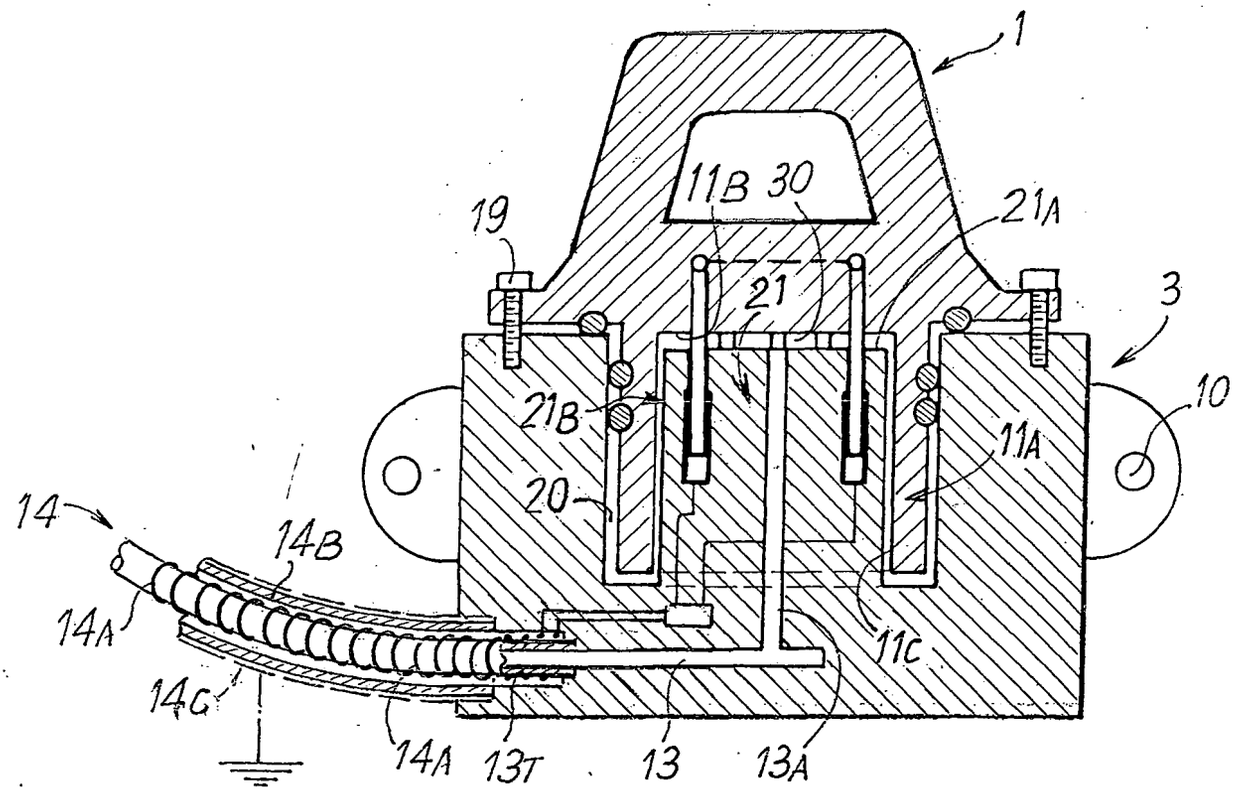
(54) **Pressurized electrical interconnection device**

(57) Electrical interconnection device produced with a socket (1) and a plug (3) which are coupled to form therewithin a sealed space or interspace (30), said interspace (30) being fluidly connected to a pressurized circuit.

Fig. 4



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Description

[0001] This invention relates to an electrical interconnection device for pumps housed in wells of sewage systems or the like.

[0002] Dynamic sewage systems have wells to collect waste water or sewage, wherein one or more pipes converge and from which the sewage is raised by means of submersible pumps and sent to a section at a greater height of the sewage system by means of piping connected to said pumps, while electrical supply and control cables connect these pumps to a control unit outside the well.

[0003] Although these wells are usually provided with at least two pumps, in order to simplify reference will be made hereunder to a well with only one pump.

[0004] In a well of this kind the pump requires regular maintenance, and therefore must be periodically removed from the well and subsequently repositioned therein, separating it from the pneumatic piping and from the electrical connections thereof.

[0005] Current technology allows the hydraulic piping to be connected to and separated from the pump rapidly and simply. In fact, to facilitate and accelerate movement of the pump, the hydraulic connections are today produced with sealed separable pipes, generally comprising two flanges which are coupled with a gasket, advantageously without the use of bolts but making use of the weight of said pump.

[0006] However, currently it is difficult to perform operations to connect and disconnect the electrical cables connecting the pump to the control unit outside the well with the same rapidity. In fact, the formation of aggressive gases and foams inside the well rapidly damages conventional electrical contact devices such as sockets, plugs or terminal junction boxes, making them somewhat unreliable and unsafe in this type of environment.

[0007] The simplest procedure, which could be used to solve the aforesaid drawbacks, is to wind the electrical cables in coils outside the well at the same time as the pump is moved. However, this procedure is not used due to the further drawbacks involved; in fact, removal of a cable several tens of meters in length and which has been housed in a cable duct for a long time is not a rapid and risk-free operation.

[0008] To date the procedure generally used instead involves cutting through the electrical cable in a point easily accessible for the operator, for example in proximity to the manhole, prior to lifting the pump. This procedure in fact allows a simple and rapid operation to remove the pump.

[0009] The main drawback of this procedure lies in the fact that during subsequent repositioning of the pump inside the well skilled technicians are required to reconnect the cable; this is generally done be producing a "sealing box", which is a device produced on the site with terminals to which the electrical cables are connected and then embedded in resin.

[0010] This procedure is costly, as both the resin and the operator have a high cost; moreover, the length of time required for reconnection is considerable, as the resin must also be allowed to dry (about 1 hour).

SUMMARY OF THE INVENTION

[0011] The main object of the present invention is to produce an electrical interconnection device which allows simple and rapid contact of the electrical cables between a pump, operating in environments in which aggressive substances form, and an outside control unit, producing at the same time an electrical interconnection device which protects the electrical contacts from any infiltrations of said substances.

[0012] In substance, the subject of the present invention is an electrical interconnection device characterized in that it comprises therewithin a sealably closable space or interspace fluidly connected to a pressurized circuit, with the electrical connection between the supply and control cables of a pump inside the well and the respective cables of a control unit outside said well being produced inside this space or interspace.

[0013] In the preferred embodiment this electrical interconnection device is advantageously produced with a plug connected to the pump, which is coupled to a socket connected to the control unit, forming a sealed interspace, which is filled with a pressurized fluid.

[0014] Nonetheless, different electrical contact devices comprising the principle on which the invention is based, such as sealably closable junction boxes or the like, would also be possible.

[0015] The pressure inside the interspace is advantageously obtained by means of a pressurized circuit comprising, in the simplest embodiment thereof, a pressure switch and a compressor, which maintain the pressure inside the interspace, optionally a secondary contact (normally integral with a pressure switch) to shut down the circuit at any moment.

[0016] In a particularly advantageous embodiment of the invention this electrical interconnection device is fixed to the edge of the opening of the manhole to allow rapid, easy and safe action by the operator.

[0017] The device according to the present invention is advantageously used with a pressurized circuit to control pumps, such as the one described in the patent EP 0.580.558 by the same applicant.

[0018] In brief, this circuit exploits a pressurized submerged sealed flexible probe to calculate the quantity of sewage present inside the well and consequently control operation of the pump and also guarantee that the pump inside the well is always submerged in the liquid, to guarantee adequate cooling thereof.

[0019] This pressurized circuit is advantageously connected to the interspace of the electrical interconnection device by means of a branch.

[0020] In the case in which the level of sewage inside the well is constant, the pressure inside the pressurized

circuit is equivalent to the pressure due to the liquid column above the flexible probe. The pressure of this circuit and therefore the pressure inside the interspace of the electrical interconnection device is greater than the atmospheric pressure.

[0021] When this circuit is started up, the pressure can be adjusted manually even with a "dry well", so that it is always above atmospheric pressure, as the mechanical resistance offered by the walls of the flexible probe to their dilation must be overcome. As the gas forming inside the well can never reach said start-up pressure, the pressure inside the interspace is greater than the pressure inside the well even during start-up with a dry well.

[0022] During change in the level of sewage in the well the pressure inside the circuit is subjected to a variation, but always remains at a higher value than that of the atmospheric pressure, guaranteeing the necessary pressure in the interspace of the device.

[0023] If there are leaks in the circuit, the function of the compressor is to maintain the pressure in the circuit constant so that the pressure inside the interspace is always greater than the atmospheric pressure.

[0024] In this case, the known control unit of the circuit signals an operating fault, advantageously by radio to a central control unit, and the necessary maintenance is programmed.

[0025] Moreover a self-diagnostics system can advantageously be provided for the pneumatic seal of the interspace of the electrical interconnection device and also of the pneumatic system upstream of the device; advantageously, in the case in which a plurality of these devices are used in the same pressurized circuit, by selectively closing each valve present upstream of each device and analyzing the behavior of the pressurized circuit.

[0026] Moreover, with this system the power supply to the pump is automatically interrupted as soon as the plug is disconnected from the socket, without the need for mechanical shutdown, even if the operators in charge of these tasks should forget to manually disconnect the power supply before disconnecting the socket. In fact, in this case the pressure in the circuit drops suddenly to a value in proximity to the atmospheric pressure and the control unit shuts off the power supply, thereby guaranteeing the safety of the operators.

[0027] It is advantageous to use a "blank" plug to be inserted in a socket to close the pneumatic circuit referring to an unused electrical circuit.

[0028] In this embodiment the device according to the invention is therefore particularly effective to solve the drawbacks of the conventional electrical interconnection method, proving simple and inexpensive.

[0029] In particular, this system allows a pressure exceeding the external pressure to be maintained inside the interspace of the electrical interconnection device, in order to in any case protect the internal electrical contacts from any infiltrations of aggressive substances.

[0030] The use of different systems or circuits, which obtain the same objects, can also be used with the present invention, such as conventional float systems or different pressure circuits to control the pumps, for example microprocessor or PLC systems.

BRIEF DESCRIPTION OF THE DRAWINGS

[0031] The present invention can be better understood and the numerous objects and advantages thereof shall be apparent to those skilled in the art with reference to the accompanying schematic drawings, which show a non-limiting practical example of the finding.

[0032] In the drawing:

Figure 1 schematically shows a vertical section of a socket and a plug for electrical interconnection according to the invention;
Figure 2 schematically shows a section according to II-II in Figure 1;
Figure 3 schematically shows a view of the electrical socket according to III-III in Figure 2;
Figure 4 schematically shows the socket and the plug of the previous figures sealably coupled;
Figure 5 schematically shows the device of the previous figures inserted in a pneumatic control circuit of pumps;
Figure 6 schematically shows the section of the plug according to VI-VI in Figure 5; and
Figure 7 schematically shows a well equipped according to the invention.

DETAILED DESCRIPTION OF THE PREFERRED EMBODIMENT

[0033] The drawings, wherein identical parts are indicated with the same numbers in all the various figures, show an electrical interconnection device according to the invention comprising a plug 1 and a socket 3, see Figures 1 to 6.

[0034] In the embodiment illustrated, the pin 1 is composed of an essentially cylindrical wall 11A, of a base 11 B, inside which the electrical contacts 15A are fixed, and of a handle 17. On the outside of the cylindrical wall 11A there are preferably at least two gaskets 7A, 7B and at least a further gasket 7C is provided to function frontally.

[0035] Screws 19 received in a plurality of holes at the edges of the plug 1 allow the plug 1 to be fixed to the socket 3.

[0036] The socket 3 comprises, inside a cavity 20, a central body 21, incorporated in which are insertion contacts 15B for the respective contacts 15A of the plug 1 and in which a branch 13A of a channel 13 of a pressure circuit is produced.

[0037] In the preferred embodiment the channel 13 extends inside the lower part of the socket 3.

[0038] Advantageously, a plurality of electrical cables

14A covered with a coating 14B preferably made of a plastic material and protected by a coaxial metal mesh braid 14C to form as a whole a cable 14 for electrical and fluid connection, are wound about the tubular continuation 13T of the channel 13. In fact, the cables 14A advantageously make the electrical connection between the contacts 15B of the socket 3 and a control unit 33, shown in Figures 5 and 7.

[0039] The metal braid 14C is advantageously electrically grounded to guarantee, besides mechanical protection, also electromagnetic protection of the cables 14A.

[0040] Further embodiments of the channel 13, for example completely external to the socket 3, or further embodiments of the cables 14A-14C, for example separated from the channel 13, would also be possible.

[0041] The socket 3 advantageously has holes 19A for fixing the plug 1 by means of screws 19 and holes 10 for fixing the socket 3 to a wall of the well.

[0042] Figures 2 and 3 schematically show the plug 1 in an advantageous system for electrical connection between the connectors 15A of the plug 1 and a cable 23, composed of a plurality of electrical supply and control cables 23A for a pump, not represented in the figure, positioned inside the well. Each electrical cable 23A is advantageously connected to a terminal 24, in turn connected to each of the connectors 15A.

[0043] In an advantageous embodiment a casing 25 is provided, see Figures 2 and 3, which encloses the area of the terminals 24 and which preferably is provided with holes 28 and an access hatch 27. In this way, after the operator has made the electrical connection between the cables 23A and the terminals 24 through the open hatch 27, the hatch 27 is closed and the casing 25 is filled, preferably with thermoplastic material or epoxy resin through holes 28. This offers increased efficiency and safety of the electrical contacts between the cable 23 and the plug 1 at a limited cost.

[0044] Figure 4 schematically shows the plug 1 inserted in the socket 3.

[0045] The space or interspace 30 produced in the area of electrical interconnection of the contacts 15A and 15B of the plug 1 and respectively of the socket 3 (and partly composed of the cavity 20) is mainly enclosed by the following surfaces:

- an inner surface 11C of the cylindrical wall 11A of the plug 1;
- the base 11B of the cylindrical wall 11A comprising the connectors 15A of the plug 1;
- an upper surface 21A of the central body 21 of the socket 3;
- the circular wall 21 B of the central body 21 of the socket 3.

[0046] The interspace 30 can advantageously be sealably closed by means of gaskets 7A, 7B fixed preferably to the outer surface of the cylindrical wall 11A of the plug 1, while the screws 19 fasten the plug 1 against the socket 3 compressing the gasket 7C.

[0047] Figure 5 schematically shows the electrical interconnection device of the previous figures used in a pressurized circuit of the type described in the patent EP 0,580,558, while Figure 7 schematically shows a well equipped according to the invention.

[0048] In this advantageous embodiment of the invention the channel 13, see Figure 5, is fluidly connected both to a sealed flexible probe 29 disposed under the level of the liquid to be lifted inside a well 31, see also Figure 7, and to a compressor 33B of a control unit 33; the latter controls a lift pump 35 as a function of the height of the liquid inside the well 31.

[0049] In this embodiment of the invention the channel 13 passes completely through the base of a socket 3B and, by means of the pneumatic branch 13A, connects the interspace 30 to the aforesaid pressurized circuit. A valve 40, see Figures 5 and 6, is provided inside the socket 3B and connected to the channel 13 before it leaves said socket as a cable 23, which reaches the probe 29. When this valve 40 is closed the submerged probe 29 is isolated and the gasket between the socket 3 and the plug 1 is advantageously tested.

[0050] The supply and control cables 40C of the valve 40 are advantageously wound around the channel 13 together with the cables 14A of the pump 35.

[0051] All in all, the control unit 33 is electrically connected to the pump 35 by means of a circuit comprising in succession the electrical cables 14A inside the cable 14, the electrical connection between the socket 3B and the plug 1 and lastly the cable 23.

[0052] The control unit 33 is instead fluidly connected to the submerged probe 29 by means of the pipe 13 inside the cable 14 and is connected to the interspace 30 of the device according to the invention by means of the branch 13A of the pipe 13.

[0053] Figure 6 schematically shows the section VI-VI of the socket 3A in Figure 5, advantageously composed of said central body 21, on which said contacts 15B and said branch 13A of said channel 13 of the pressurized circuit are produced. The channel 13 passes completely through the socket 3B and is connected to the valve 40 inside said socket.

[0054] Figure 7 schematically represents the system inside a well.

[0055] Under a manhole 41, the electrical interconnection device according to the invention is represented, produced by the socket 3B and by the plug 1. The plug 1 is electrically connected to a submersible pump 35 by means of the cable 23, while the socket 3B is electrically and fluidly connected to the control unit 33 by means of the cable 14. The pipe 13 terminates the pneumatic connection between the socket 3B and the submerged probe 29.

[0056] Moreover, a pipe 43 allows the removal of sewage from the well 31 while sliding guides 45 are used to move the pump 35.

[0057] With the system described above both removal and installation of a pump inside a well are particularly inexpensive, efficacious and simple to perform.

[0058] In fact, by opening the manhole 41 it is possible to disconnect the pipes 43 from the pump 35 in a known way, to disconnect the electrical connection of the pump 35 by detaching the plug 1 from the socket 3B thereof, and to lift the pump 35 by pulling the chain 45P on the sliding guides 45.

[0059] Installation takes place by repositioning the pump 35 at the bottom of the well and connecting the pipe 43 and the plug 1.

[0060] These devices can be connected and configured with different systems and combinations, such as a connection in series or in parallel of said electrical or pneumatic connections.

[0061] It is understood that above description and illustration merely represents a possible non-limiting embodiment of the invention, which may vary in forms and arrangements without however departing from the scope of the concept on which the invention is based. Any reference numerals in the appended claims are provided purely to facilitate the reading thereof in the light of the preceding description and of the accompanying drawings, and do not in any way limit the scope of protection.

Claims

1. Electrical interconnection device for pumps (35) housed in wells (31) of sewage systems, **characterized in that** it comprises therewithin a space or interspace (30) sealably closable wherein the electrical contact between two parts of circuit is produced, said space or interspace (30) being fluidly connected to a pressurized circuit.

2. Electrical interconnection device as claimed in claim 1, **characterized in that** it is produced with a socket (3) and a plug (1) which are coupled to form therewithin said sealed space or interspace (30), said interspace (30) being fluidly connected to said pressurized circuit.

3. Electrical interconnection device as claimed in claim 2, **characterized in that** said plug (1) is composed of an essentially cylindrical wall (11A), of a base (11B) inside which electrical contacts (15A) are fixed, of a handle (17) and, on the outside of the cylindrical wall (11A), of at least one gasket (7A and/or 7B and/or 7C).

4. Electrical interconnection device as claimed in claim 3, **characterized in that** said plug (1) comprises a plurality of holes which allow said plug (1) to be fastened to said socket (3) by means of screws (19).

5. Electrical interconnection device as claimed in claim 2, **characterized in that** said socket (3) advantageously comprises a central body (21) on which contacts (15B) are produced for insertion of said respective contacts (15A) of said plug (1) and a branch (13A) fluidly connected to a channel (13) of said pressurized circuit.

6. Electrical interconnection device as claimed in claim 5, **characterized in that** said channel (13) passes inside the lower part of said socket (3).

7. Electrical interconnection device as claimed in claim 6, **characterized in that** a plurality of electrical cables (14A) covered by a coating (14B), preferably made of plastic material, are wound around said channel (13).

8. Electrical interconnection device as claimed in claim 7, **characterized in that** said coating (14B) is protected by a coaxial metal mesh braid (14C).

9. Electrical interconnection device as claimed in claim 8, **characterized in that** said metal braid (14C) is electrically grounded.

10. Electrical interconnection device as claimed in claim 5, **characterized in that** said channel (13) is completely external to said socket (3).

11. Electrical interconnection device as claimed in claim 5, 6 or 10, **characterized in that** said cables (14A-14C) are separated from said channel (13).

12. Electrical interconnection device as claimed in claims 2 to 11, **characterized in that** said socket (3) comprises holes (10) for fixing said socket (3) to a wall of said well (31).

13. Electrical interconnection device as claimed in claims 2 to 4, **characterized in that** said connectors (15A) of said plug (1) are electrically connected to a plurality of electrical supply and control cables (23A) for said pump (35) by means of terminals (24), in turn connected to said connectors (15A).

14. Electrical interconnection device as claimed in claim 13, **characterized in that** said terminals (24) are enclosed by a casing (25).

15. Electrical interconnection device as claimed in claim 14, **characterized in that** said casing (25) has holes (28) and an access hatch (27).

16. Electrical interconnection device as claimed in claim 15, **characterized in that** said casing (25) is fillable with thermoplastic material or epoxy resin through said hole (28).

17. Electrical interconnection device as claimed in claim 1 and/or 2, **characterized in that** said space or interspace (30) is produced in the area of electrical interconnection of said contacts (15A; 15B) of said plug (1) and respectively of said socket (3) and is enclosed by at least one of the following surfaces:

- an inner surface (11 C) of said cylindrical wall (11A) of said plug (1);
- the base (11 B) of said cylindrical wall (11A) comprising said connectors (15A) of said plug (1);
- an upper surface (21A) of said central body (21) of said socket (3);
- the circular wall (21 B) of said central body (21) of said socket 3.

18. Electrical interconnection device as claimed in claim 1, 2 and/or 17, **characterized in that** said interspace (30) is sealably closable by means of said gaskets (7A, 7B) fixed to the outer surface (21 B) of said cylindrical wall (11A) of said plug (1) and said gasket (7C) is included between the bodies of said socket (3) and of said plug (1).

19. Electrical interconnection device as claimed in claim 18, **characterized in that** it is fluidly connected both to a sealed flexible probe (29) disposed under the level of the liquid to be lifted inside said well (31), and to a compressor (33B) of a control unit (33), which controls said lift pump (35) as a function of the height of the liquid inside said well (31).

20. Electrical interconnection device as claimed in at least one of the previous claims, **characterized in that** said channel (13) passes completely through the base of said socket (3B).

21. Electrical interconnection device as claimed in claim 20, **characterized in that** said channel (13) connects said interspace (30) to said pressurized circuit by means of said pneumatic branch (13A).

22. Electrical interconnection device as claimed in claim 21, **characterized in that** a valve (40) is included inside a socket (3B) and connected to said channel (13) before it leaves said socket.

23. Electrical interconnection device as claimed in claim 22, **characterized in that** supply and control cables (40C) of said valve (40) are wound around said channel (13) together with said cables (14A) of said pump (35).

24. Electrical interconnection device as claimed in at least one of the previous claims, **characterized in that** said control unit (33) is electrically connected to said pump (25) by means of a circuit comprising in succession said electrical cables (14A) inside said cable (14), the electrical connection between said socket (3B) and said plug (1) and lastly said cable (23).

25. Electrical interconnection device as claimed in at least one of the previous claims, **characterized in that** said control unit (33) is fluidly connected to said submerged probe (29) by means of said pipe (13) inside said cable (14) and is connected to said interspace (30) by means of said branch (13A) of said pipe (13).

26. Electrical interconnection device as claimed in at least one of the previous claims, **characterized in that** it is positioned under a manhole (41).

27. Electrical interconnection device as claimed in at least one of the previous claims, **characterized in that** said plug (1) is electrically connected to said pump (35) by means of said cable (23) and the socket (3B) is electrically and fluidly connected to said control unit (33) by means of said cable (14).

28. Electrical interconnection device as claimed in claim 27, **characterized in that** said pipe (13) terminates the pneumatic connection between said socket (3B) and said submerged probe (29).

29. Electrical interconnection device as claimed in at least one of the previous claims, **characterized in that** it comprises further electrical interconnection devices electrically and/or fluidly connected in series with one another.

30. Electrical interconnection device as claimed in claim 1 and/or 2, **characterized in that** it is composed of a junction box or the like, sealably closable.

31. Method of positioning a pump (35) inside a well (31) of a sewage system, **characterized in that** it comprises one or more of the following phases:

- opening said manhole (41) of said well (31);
- inserting said pump (35) inside said well (31) by means of tackle;
- connecting said pneumatic pipes (43) to said pump (35);
- manually connecting said electrical interconnection device (1, 3);
- fastening said electrical interconnection device (1, 3);
- testing the seal of said device (1, 3);
- closing said manhole (41) of said well (31);
- starting up said compressor (33B) of said pressurized circuit.

32. Method as claimed in claim 31, **characterized in that** fastening of said electrical interconnection device (1, 3) is produced by means of fastening screws.

33. Method for removing a pump (35) housed in a well (31) of a sewage system, **characterized in that** it comprises one or more of the following phases:

- opening said manhole (41) of said well (31);
- disconnecting said electrical interconnection device (1, 3);
- separating said hydraulic pipes (43) from said pump (35);
- lifting said pump (35) on sliding guides (45);
- closing said manhole (41) of said well (31).

34. Method as claimed in claim 33, **characterized by** the further phase of manually interrupting the power supply to said pump (35) before disconnecting said electrical interconnection device (1, 3).

35. Method for testing said device, **characterized in that** it comprises at least one of the following phases:

- closing a valve (40) upstream of said electrical interconnection device (1, 3) to be tested;
- starting said compressor (33B) of said pressurized circuit;
- checking the pressure inside said circuit by means of a gauge;
- opening said valve (40).

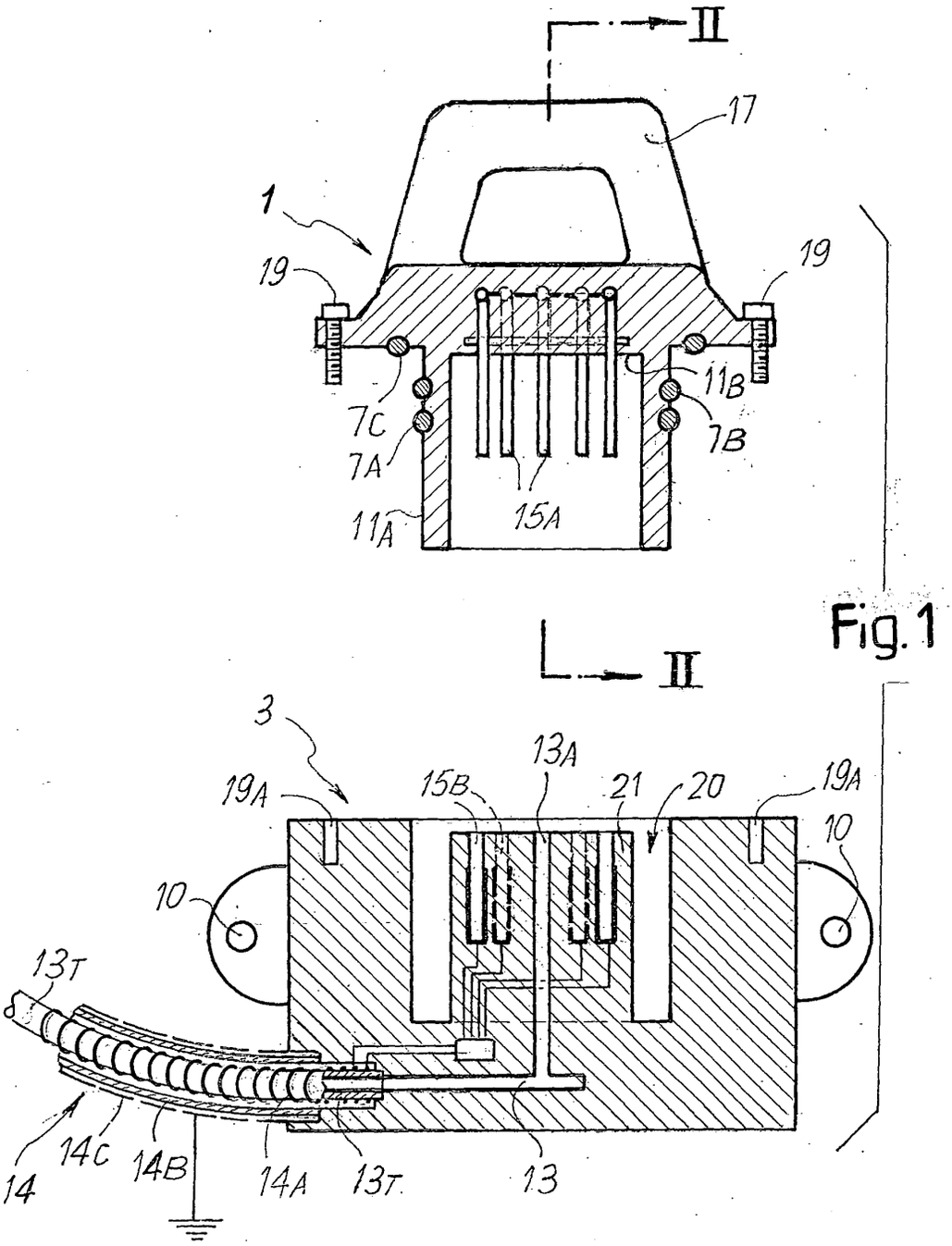
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Fig.1

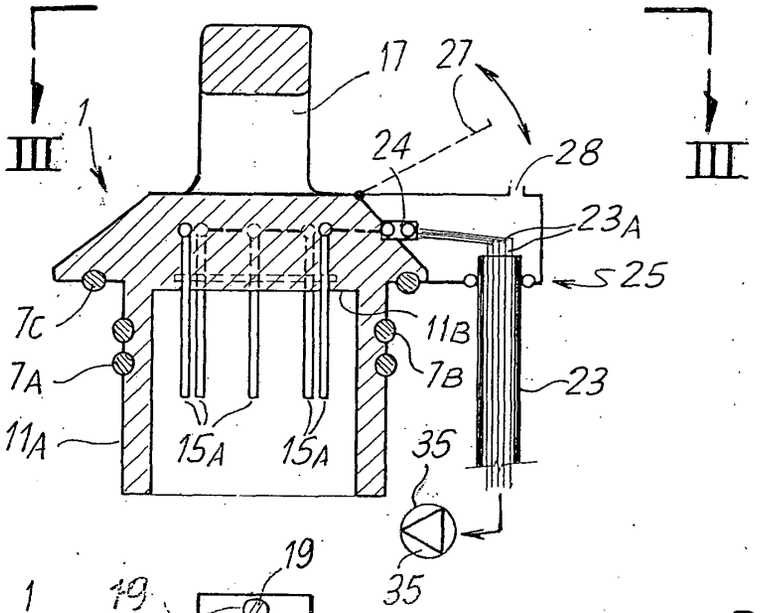


Fig. 2

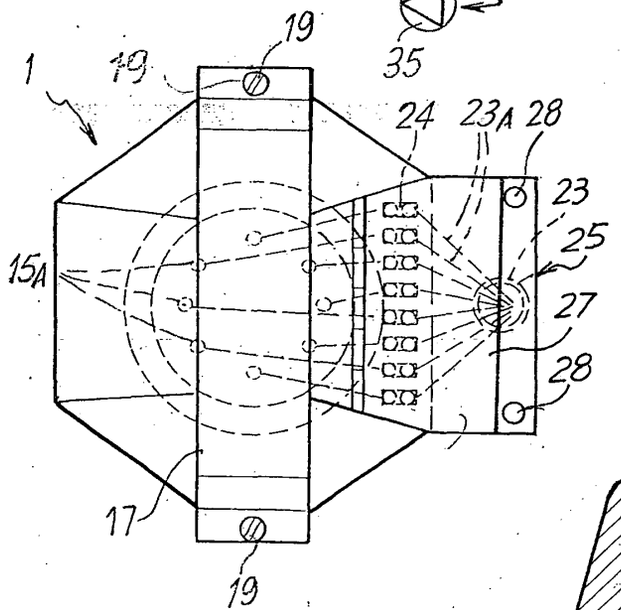


Fig. 3

Fig. 4

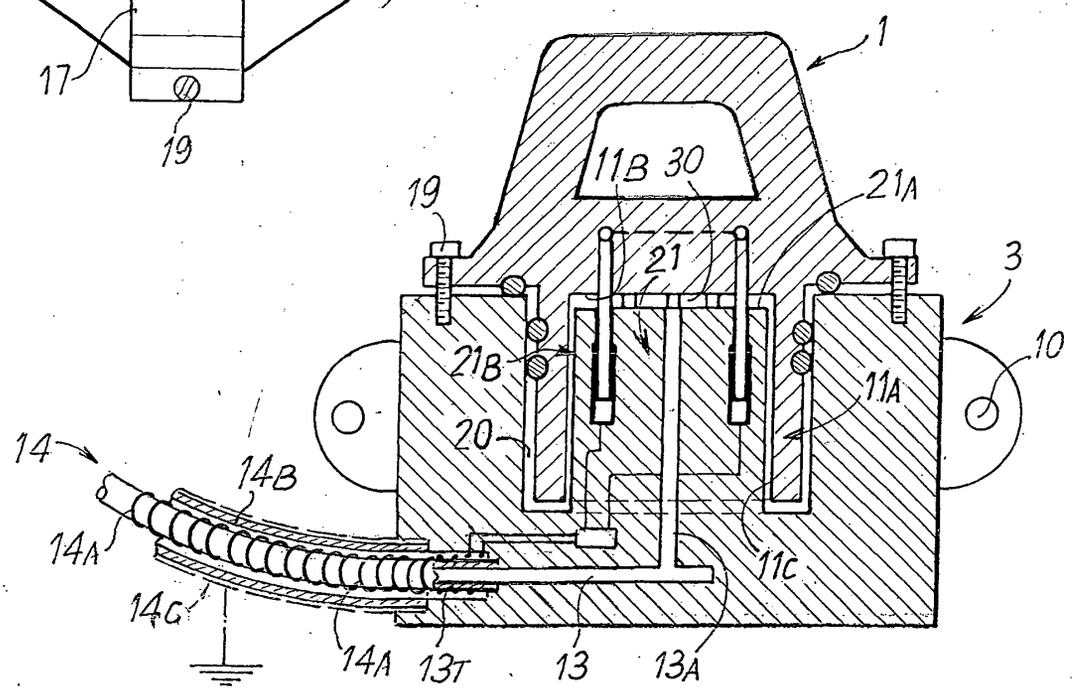
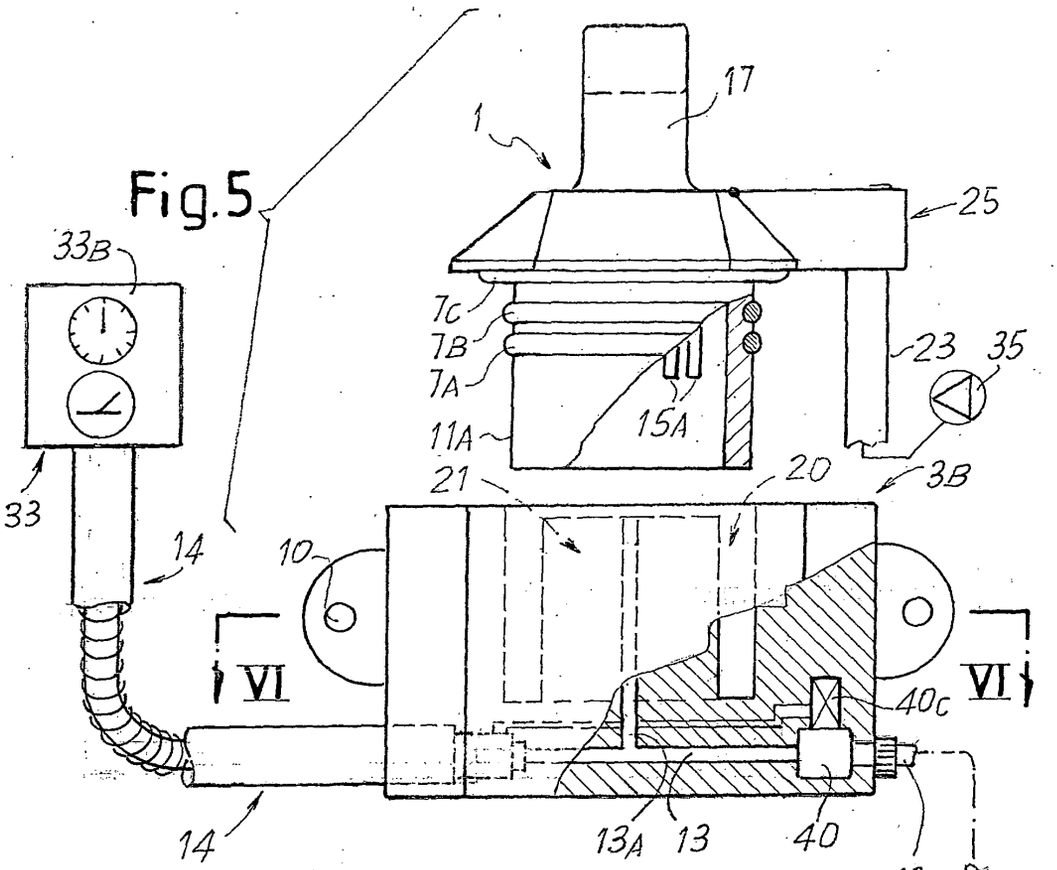


Fig.5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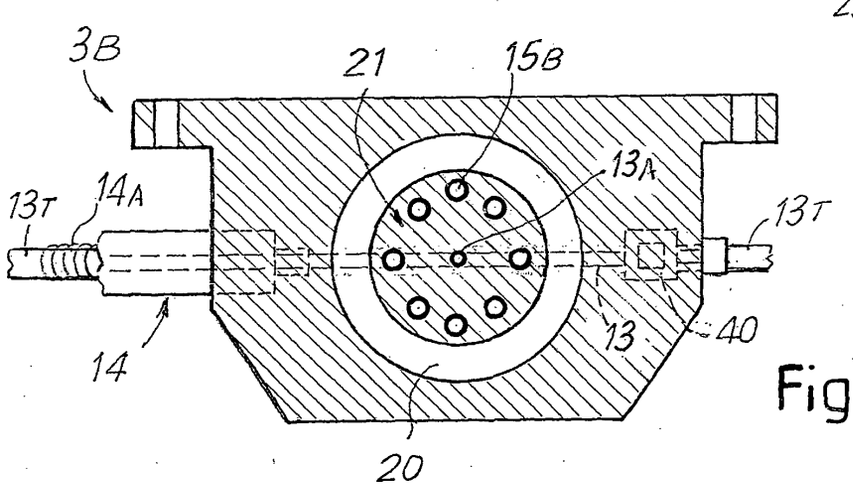
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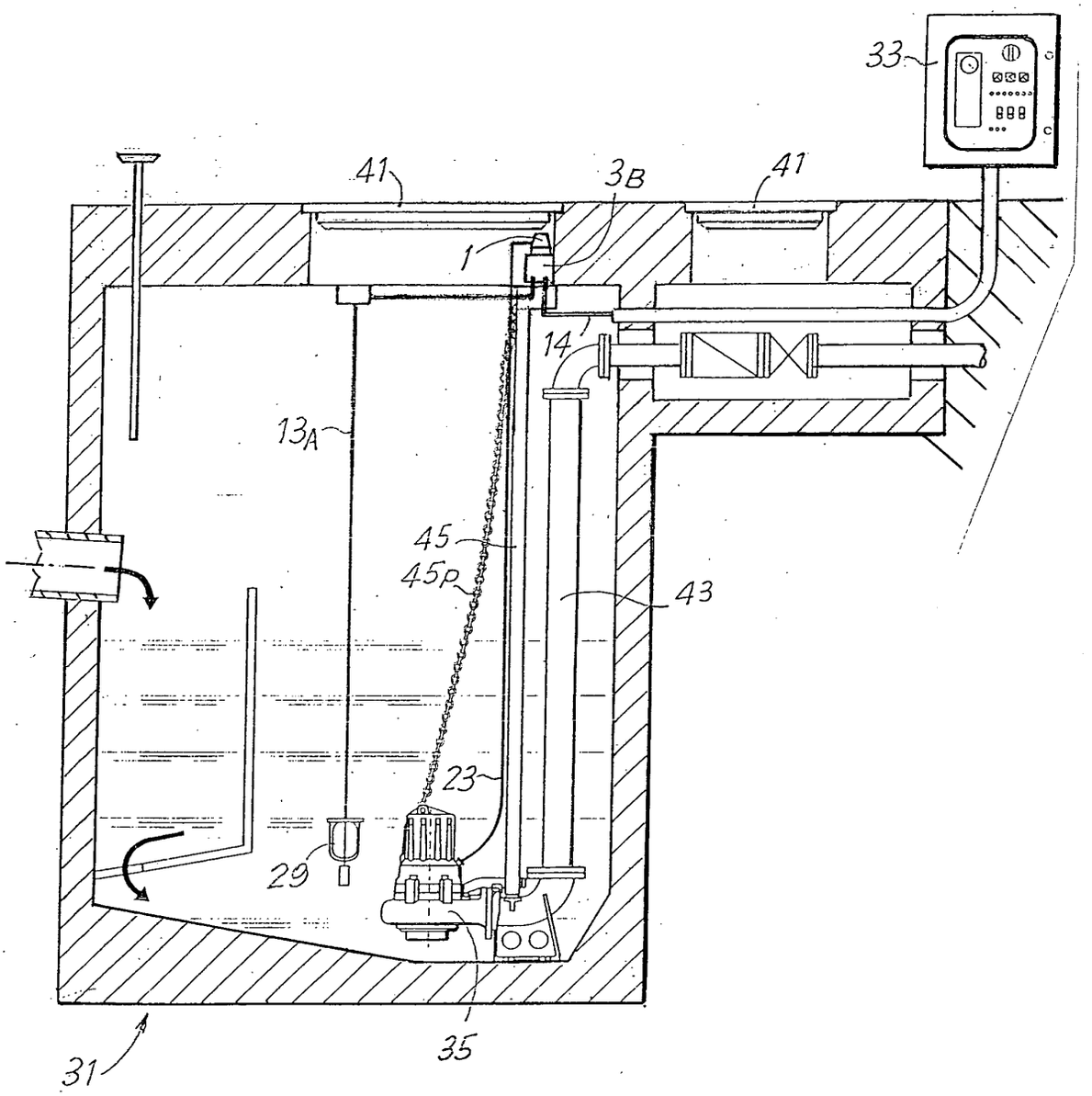
Fig. 6

Fig. 7



European Patent Office

EUROPEAN SEARCH REPORT

Application Number
EP 05 42 5288

DOCUMENTS CONSIDERED TO BE RELEVANT

Category	Citation of document with indication, where appropriate, of relevant passages	Relevant to claim	CLASSIFICATION OF THE APPLICATION (Int.Cl.7)
X	US 5 254 011 A (ISHIKURA ET AL) 19 October 1993 (1993-10-19) * column 3, line 22 - line 57 * -----	1,30	H01R13/637
A	US 6 254 410 B1 (SUGIYAMA MASAHIKO ET AL) 3 July 2001 (2001-07-03) -----		

TECHNICAL FIELDS SEARCHED (Int.Cl.7)

H01R
F04B
E03F

The present search report has been drawn up for all claims

Place of search	Date of completion of the search	Examiner
The Hague	26 July 2005	Bertin, M

CATEGORY OF CITED DOCUMENTS

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