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## (54) Device for the protection from corrosion of metal tank

(57) An electrode for anode or cathode protection is assembled deeply inside a tank for containing corrosive fluids, supported by a tubular element.

The essentially characteristic of the invention is that the same supporting tubular element, appropriately isolated on its external surface, acting as an electric conductor for connecting the electrode to the metal structure to be protected.

The main advantages of the invention provide the possibility of using the sheath of the sensor of a thermostat as a tubular element; no hindrances inside said sheath; the simplicity of the device and of the electric connecting operations.

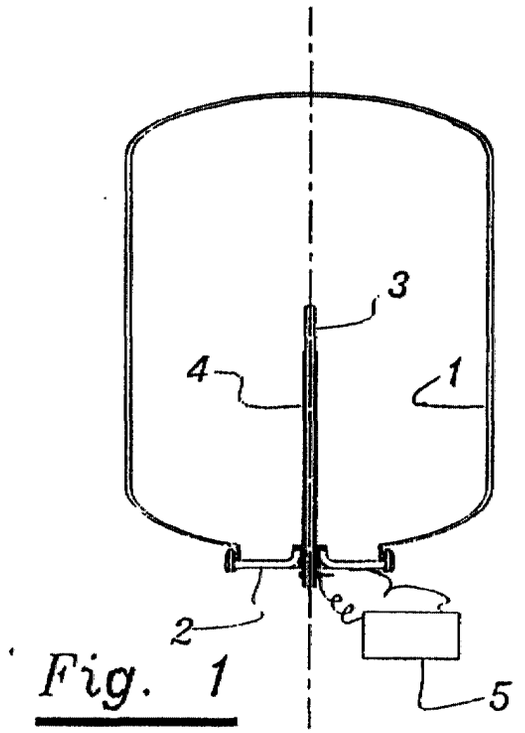


Fig. 1

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## Description

### DESCRIPTION

**[0001]** The present invention relates to a device for electrochemical protection from corrosion of metal tanks for fluids, in particular metal tanks containing hot water; more in particular, the invention relates to:

- the cathode protection, so-called "with impressed currents";
- the cathode protection with sacrificial anode;
- the anode protection.

**[0002]** The present invention also relates to the tanks using such a device, i.e. electric and/or gas storage water heaters.

**[0003]** For ease of exposure the present discussion will refer in particular to the use of the device in a storage water heater having cathode protection with impressed currents.

**[0004]** Many corrosion protection methods for metal tanks are known and extensively discussed in literature, in particular electric cathode and anode protection methods are well known.

**[0005]** In order to provide cathode protection, the potential of the metal structure to be protected is made more negative with respect to the potential of the aggressive environment, in this particular instance water, which metal structure is exposed. The potential reduction is obtained causing direct current flow from a first electrode (anode) to the metal structure to be protected, which is acting as a second electrode (cathode) through the aggressive environment being electrically conductive.

**[0006]** The current may be generated by galvanic way between a less noble metal than the one to be protected (such as Mg, Zn), acting as an anode, and the metal to be protected, which acts as a cathode electrode; this is the instance of cathode protection with a so-called sacrificial or consumable anode.

**[0007]** Current circulation can also be obtained applying the current by means of an external generator; this is the instance of the cathode protection with "impressed current".

**[0008]** Anodic protection is only possible for so-called active-passive metals, wherein passivation phenomena are obtained at determined potentials; it is obtained bringing the structure to be protected to a higher potential than the other electrode, up to a passivation value; in this instance the structure to be protected will be the one acting as an anode; the voltage required is obtained in general by means of a voltage generator.

**[0009]** Cathode protection with a sacrificial anode is very simple and of low cost initially; however, it has the drawback of entailing anode consumption and its consequent replacement through a technical man at regular intervals; if such operation is forgotten, the tank undergoes fast corrosion.

**[0010]** Anodic protection has the advantage of requiring very low current consumption; however, in order to be efficient it requires the application of a closely controlled exact voltage value under and above of which the metal structure is not in the passivation area, and it is rapidly subject to corrosion; for these reasons the method is more suitable for protecting industrial systems rather than highly consumable products; anyway, the device covered by the present invention is well appropriate for such a protection type.

**[0011]** Since cathode protection with a non consumable anode is rather simple to obtain, it has been spreading for the past few years also for high consumable products in replacement of sacrificial anodes; since the electrode acting as anode has to be manufactured from expensive materials to avoid corrosion, there is a need for optimising materials utilization and assembly methods, in particular for large series productions.

**[0012]** In the following, save if stated otherwise, reference will be made in particular to cathode protection with impressed current and the electrode intended as a non consumable anode for protecting the metal structure.

**[0013]** In order to ensure that the whole surface to be protected will receive a sufficient amount of current, may be required several electrodes but for small tanks, up to some hundreds litres capacity, it is enough to place one electrode alone in a central position; however, it is very important to have quite a uniform current supplied to the surface to be protected, otherwise some areas will not receive a sufficient amount, whereas in other areas the excessive current density may cause water electrolysis with hydrogen production.

**[0014]** Patent application DE 26 21 962 provides an electrode that, fastened to two isolating supports, across the whole water heater. The metal surface is protected rather uniformly but at the cost of excessive large electrode dimensions; the suggested assembly, which is an apparently simple one, ignores the presence of internal bulky elements such as electric heaters and thermostat sheaths.

**[0015]** US patent 4 407 711 provides two embodiments for anode manufacture and assembly; they both laborious, particularly concerning electric connections.

**[0016]** US patent 4 434 039 looks like an improvement of the previous one, where an anode consisting of a filament enwrapped about a rod of isolating material ensures a more uniform current supply to the surface to be protected, since filament turns of the filament are narrower in line with the areas near to the tank covers; however, the manufacturing difficulties of the previous patent are still not resolved.

**[0017]** Utility model DE 88 15 140 provides a sacrificial electrode consisting of the sheath of the sensor of the thermostat (Fig.1) or having the electrode consist of one (Fig. 2) or more (Fig. 3) cylindrical hollow rods inserted on the thermostat sheath itself, leaving the areas

housing the sensors uncovered. The embodiment shown in Fig. 1 is not a very realistic one, since due either to cost and/or mechanical reasons the material suitable for acting as an anode will hardly perform a sheath function too. In all the embodiments illustrated, the electrode will take an asymmetric position inside the tank.

**[0018]** Patent application EP 0 771 889, related to a cathode protection with impressed current, provides for positioning the electrode at the top of the sensors sheath cutting their end away and replacing it with a plug made from isolating material, wherein the electrode itself is engaged and connected then to the current generator by means of a cable running inside said sheath. This solution, quite simple from a manufacturing standpoint, allows arranging the electrode in a central position with respect to the surface to be protected; however, also this solution is not faultless. As a matter of fact, the presence of the cable does not allow an intimate contact between the temperature sensors and sheath along its whole generating line; on the contrary, enough clearance must be ensured to avoid difficult insertion and/or extraction of the sensors or even breaking or loosening of the cable. Moreover, such a solution clearly developed for the assembly electrodes in large series production implementing fast small changes to the previous project, does not create a valid base for subsequent more advanced industrial operations; for example, the possibility of performing automated insertion of the electrode cable in the sheath and its connection to the generator appears quite doubtful.

**[0019]** Therefore, according to the present state of the art solutions are indicated, which are uselessly expensive or unable to warrant the required uniformity of the impressed current density or unable to perform automated assembly operations.

**[0020]** It is the object of the invention, in case of use an electrode for anodic or cathode protection against corrosion of a metal tank, wherein the electrode is arranged substantially in a central position inside the metal tank, to ensure electric connection between the electrode and the tank itself without the need of electric cables, at least for the distance between the electrode itself and the external surface of said tank.

**[0021]** A further object of the invention is to fully exclude the need of electric connecting cables for closing the electric protection circuit.

**[0022]** A further object of the invention is to use the sheath of the sensors of the thermostats for supporting the electrode, leaving the inside of the sheath fully free for the sensors themselves.

**[0023]** A further object of the present invention is to allow full automation of the connection between the electrode, sheath and current generator.

**[0024]** These and other objects are obtained through a tubular element made of electric conductive material, covered, at least over all its external surface in contact with the corrosive environment, by a layer or film of isolating material, and bearing an electrode on one end electrically and mechanically connected to said end, whereas the other end of the tubular element is fastened to the metal structure to be protected through means capable of ensuring electrical isolation of said tubular element from said metal structure; the whole as it will be better described and claimed in the following.

**[0025]** The features of the device for protecting metal tanks from corrosion according to the invention are now described according to some preferred but not limited embodiments.

The Fig. 1 is a section view of a metal tank closed by a metal flange and having an electrode inserted inside, according to the invention.

The Fig. 2 shows, in detail, how the electrode according to the invention is fastened to its support, represented as a sectioned view.

The Fig. 3 shows, according to an embodiment of the invention, an area in line with the flange of the water heater, where electric connections between the electrode, current generator and tank are executed; moreover, also one of the possible fastening means of the electrode support to the tank flange is shown as a section view.

The Fig. 4 shows the complete device according to a possible embodiment of the invention.

The Fig. 5 shows two implementations, independent to each other, of the illustration in figures 3 and 4: the first implementation concerns the fastening procedure of the electrode support to the flange; the second one relates to the electric connections of the current generator.

The Fig. 6 shows an implementation of the electric connections of the generator with respect to the illustrations in the previous figures.

The Fig. 7 shows the electrode support screwed on a tank wall.

The Fig. 8 shows, according to a possible implementation of the invention, an internal detail of the electrode support near the electrode itself.

**[0026]** None of the above figures shows the connections to the mains for the supply of the generator.

**[0027]** In Fig. 1, are represented the metal tank (1) to be protected from corrosion, the closure flange (2) of the metal tank (1), usually made from steel, the protecting electrode (3), a metal tubular element (4) for the electrode support (3), a current generator (5) connected to the tubular element (4) and closure flange (2).

**[0028]** Fig. 2 shows the metal tubular element (4) having an external isolating layer (4.1) and a further likely internal isolating layer (4.2); in the illustration, the metal tubular element (4) is made of the sheath of a bulb temperature sensor (15) whose capillary is also shown (15.1); the electrode (3) is inserted on top of the metal tubular element (4) in electric contact with it, since the likely internal isolating layer (4.2) is not available in this area; is also shown a suitable sealing means (14) ap-

plied outside to fully cover the whole coupling edge between the metal tubular element (4) and the electrode (3), finally, an isolating insert (13) is shown below the electrode (3).

**[0029]** In the Fig. 3, besides some elements already mentioned above, is representing an electric connection ring (8) for connecting the metal tubular element (4) to the current generator (5) through the cable (6); more exactly, the cable (6) is fastened to the screw (8.1), whose tip penetrates through the external isolating layer (4.1) until it comes in contact with the metal tubular element (4); the other pole of the current generator (5) is connected to the closure flange (2) through the cable (7) ending to a general electric connecting element (9), such as a Faston terminal, welded to the closure flange (2); the latter is then electrically connected to the metal tank (1) by means of the clamping bolts (11) of the sealing gasket (10); moreover, a possible water seal fastening means (12) of the tubular element (4) on the closure flange (2) is also highlighted.

**[0030]** In the Fig. 4 is only representing some elements already shown in the previous figures.

**[0031]** In Fig. 5 is showed a flat closure flange (2a) with a seat (2a.1) for the metal tubular element (4) sealed in it by means of a general dope (12a); also an implementation (5a) of the current generator (5) is shown, which has a clip connector (8a) engaged on the metal tubular element (4), whose external isolating layer (4.1) is incise by it, and which is in electric contact with the closure flange (2 or 2a) through the flexible metal contact (9a).

**[0032]** The Fig. 6 shows a further implementation (5b) of the current generator (5) having a connector with a threaded bushing (8b), which engages the metal tubular element (4).

**[0033]** The Fig. 7 shows an implementation of the device according to the invention, wherein a threaded collar (2b) is fastened on the metal tubular element (4) by means of dope (12b), so that the electrode (3) supported by said metal tubular element (4) can be inserted on any tank wall (1) by screwing said threaded collar (2b) on any bushing (1a), arranged on most large tanks.

**[0034]** Finally, the Fig. 8 shows a detail of the metal tubular element (4), deprived of the internal isolating layer (4.2) and of the isolating insert (13), where the bulb temperature sensor (15) keeps a spring (16) pressed against the internal wall of the metal tubular element (4) and of the electrode (3).

**[0035]** The features of the device, already made quite clear by the illustrations in the figures, are now described in detail.

**[0036]** First of all, it should be noted how the electrode (3) can be substantially arranged in a central position with respect to the metal tank surface (1) to be protected.

**[0037]** It is obvious how the electrode (3) may be electrically connected to any device outside the tank (1) without the need of a connection cable between the electrode (3) itself and the outside of the metal tank (1); in fact, electric continuity is ensured at least up to the flange (2) or (2a), by the metal tubular element (4); the electrode (3) may simply consist of a rod made from any suitable material for such a function, such as graphite or titanium, and it is mechanically and electrically connected to the top of the metal tubular element (4) either by simple pressure insertion or plastic deformation of the end of the metal tubular element (4), just to adapt one end to the diameter of the other end, or also by screwing; the dope (14) ensures hydraulic seal, electrically isolates the edge of the metal tubular element (4) and it finally completes the mechanical coupling though being able to ensure on its own, minding to preserve electric continuity between the metal tubular element (4) and the electrode (3); said dope (14) may also be replaced by a thermo-retractable sheath to ensure both its hydraulic seal function and mechanical support, or by other equivalent means as well.

**[0038]** The metal tubular element (4) is protected outside by the isolating layer (4.1); without it also the element (4) would act as an electrode supplying current to the tank through the water or any other aggressive means contained in the tank (1), and become rapidly corroded, since it is not provided in general to have said metal tubular element (4) consisting of an appropriate material to act as an electrode; moreover, if the isolating layer (4.1) is not present, the current would not be distributed in a substantially uniform way to the tank (1). Therefore, the isolating layer (4.1) must also consist of a non porous material; since in most applications, in particular water heating, the physical conditions which is submitted the isolating layer (4.1) are not particularly heavy, many known synthetic thermosetting or thermoplastic materials are appropriate for the purpose, such as polyethylene or polypropylene; due to the same protection requirements of the metal tubular element (4), the dope (14) has to fully cover the edge.

**[0039]** If the metal tubular element (4) usefully performs the function of sheath for temperature sensors of thermostats or as a housing for other means extraneous to the protection device, an internal isolating layer (4.2) and isolating insert (13) can be provided, even if such electric isolating means are not required at all in general, as it will be noted in the following; it should only be noted now that the isolating layer (4.2) is applicable according to any known technique, such as that used for the plasticization of the internal surface of the tubes for hydraulic systems; quite advantageously, the metal tubular element (4) could use such tubes already available on the market and covered by a plastic layer both inside and outside, simply removing their internal isolating layer (4.2) in line with the coupling area to the electrode (3).

**[0040]** It should be noted that a very low voltage is required for activating the cathode protection: from some hundreds mV to some V; therefore, the thickness of the isolating layers (4.1) and (4.2) may be so low so as not to represent a thermal resistance hindering to cor-

rect temperature control of the water heater by the sensors, all the more as the latter may be in a close contact with the internal wall of the metal tubular element (4), being not hindered by any internal cable.

**[0041]** Alternatively to the bulb temperature sensor (15) illustrated in the figures, the sensor may consist of the shank of a rod thermostat or the thermistor of an electronic thermostat; the latter, as such, is electrically isolated by appropriate capsulation, whereas both the bulb sensors and shank of rod thermostat, though not being a protected metal, are not electrically connected to any exposed metal parts of the thermostat they belong to, whose housing is usually of plastic material; therefore, both the internal isolating layer (4.2) and isolating insert (13) are usually not required, because there is no risk that the temperature sensors inserted in the metal tubular element (4) may cause an undesired electric contact with metal parts of the tank; this is true at least for most known thermostats; eventually, as it is often usual practice, it will suffice to have the capillary (15.1) protected by an isolating sheath, in the case there is the risk that its turns may accidentally come into contact with metal parts.

**[0042]** The figures show, by way of example, some possible electric connections of the lower end in the metal tubular element (4) to the current generator (5) or (5a) or (5b); in all these instances the electric contact can be warranted without removing preliminarily the external isolating layer (4.1) in line with the electric connection area. According to the embodiment providing an electric connection ring (8), the screw (8.1), appropriately pointed, can penetrate through the external isolating layer (4.1); in the instance of the current generator (5a), the clip connector (8a) may have grip edges sufficiently sharp to incise said layer (4.1); finally, in the instance of a current generator (5) having a connector with a threaded bushing (8b), the latter may be self-threading and incise the metal tubular element (4). Proper clips, self-threading screws or other connecting elements already known represent optional electric connection means from the metal tubular element (4) to the current generator (5).

**[0043]** However, the same sensing element of the thermostat, let it be either a bulb and capillary or the shank of the rod thermostat, can create a safe electric connection jumper from the current generator (5) to the top of the metal tubular element (4) or directly to the lower portion of the electrode (3); eventually, to obtain a safe electric contact simple means should be provided, such as a spiral spring (16) pressed by the bulb temperature sensor (15) or by the end of the shank of a rod thermostat against the internal walls of the tubular element (4) deprived of its internal isolating layer (4.2) and/or isolating insert (13), or pressed directly against the electrode (3), whenever the latter is close enough. Using temperature sensors as electric conductors represents a particularly advantageous embodiment for integrated devices acting both as thermostats and current generators; in this case, in fact, the simple insertion of the sensor of the thermostat in its sheath, i.e. in the metal tubular element (4), puts the generator (5) in direct or indirect electric contact with the electrode (3).

**[0044]** As to the connection between the current generator (5) and the flange (2) or (2a), the electric connecting element (9) may consist of any metal connector, such as a Faston with a portion welded to the closure flange (2); additionally, for current generators of the embodiments (5a) and (5b) may be provided the flexible metal contact (9a) requiring no connecting operation, since the respective connections with clip connectors (8a) or threaded bushing (8b) also form a fastening means for the same generators (5a) and (5b) to the metal tubular element (4).

**[0045]** Obviously, the metal tubular element (4) cannot be fastened by welding to the metal structure to be protected, but the external isolating layer (4.1) does not represent a particular hindrance for the use of safe optional fastening means, already known. The figures illustrate a water seal fastening element (12), designed as a plug of elastomeric material forced inside the flared support (2.1) or a generic sealing agent (12a) to be used in the seat (2a.1), but many other known means can be suitable, such as a caulked metal bushing against the metal tubular element (4) or the metal tubular element (4) expanded against the seat (2a.1), eventually minding to protect the metal tubular element (4) with an elastomeric ring in line with the area submitted to expanding.

**[0046]** Finally, the Fig. 7 shows a general instance, in which on the metal tubular element (4) bearing the electrode (3) is sealed a threaded ring (2b) which has an appropriate diameter for assembly to any wall area of the tanks available on the market.

**[0047]** Of course, the device according to the invention can be utilized also for fastening sacrificial anodes, in which is not present any current generator; in this instance the metal tubular element (4) can be directly welded to the metal structure to be protected however, compatibly with the welding technology adopted, can be maintained the external isolating layer (4.1) on most internal distance inside the metal tank (1), to ensure proper current supply uniformity as mentioned above.

**[0048]** From the above description it will be clear how the objects provided by the invention can be obtained.

**[0049]** At present, are used electrodes available on the market assembled on a threaded seat; the rod acting in them as a real proper electrode is connected to an electric cable and then mounted on a threaded bushing from which it is electrically isolated through a proper isolating agent.

**[0050]** A main advantage of the invention is that the device allows to use a simple rod made from suitable material for the electrode (3), without pre-conditioning.

**[0051]** Another advantage provides the possibility of using as a support for the electrode (3), the top of the sheath of the sensors of the thermostat, which is arranged in a substantially central position in the tank,

without interfering the least with the sensors themselves being not necessary to introduce electric cables in the sheath.

**[0052]** Another advantage is a considerable assembly simplification, in particular the possibility of fully removing all electric wirings.

**[0053]** Of course, many other implementations and applications are still possible to the above device.

## Claims

1. Device for the electrochemical protection from corrosion of metal containers or tanks for fluids (1), in particular electric and/or gas storage water-heaters,

   - where an electrochemical protection is provided, comprising:

     a cathode protection with impressed currents or sacrificial anode
     or an anodic protection,

   - and where one or more electrodes are available, with function of anode for cathode protection or of cathode for anodic protection,

   **characterized in that**

   - at least an electrode (3) is electrically and mechanically connected to one end of a metal tubular element (4),

   said electrode (3) and said metal tubular element (4) being conveniently inserted inside of said container or tank (1),
   where the external surface of said metal tubular element (4) is covered by an external isolating layer (4.1), at least over all its contact area with the fluid contained in said tank(1).

2. Device, according to claim 1, **characterized in that** hydraulic seal of the coupling between said electrode (3) and said metal tubular element (4) is obtained by sealing means (14) which also entirely isolating the edge of said metal tubular element (4) from the corrosive environment wherein it is immersed, whereas fastening of said electrode (3) to said metal tubular element (4) is obtained with any known means, such as pressure insertion of said electrode (3) on said metal tubular element (4) and/or plastic distortion of the end of said metal tubular element (4) against said electrode (3) and/or screwing said electrode (3) and said tubular element (4) to each other and/or simply by means of said sealing means (14).

3. Device, according to claim 1 or 2, **characterized in that** said external isolating layer (4.1) also extends to all the area where said metal tubular element (4) is mechanically fastened to proper seats (2.1;2a.1; 2b) of a metal portion (2;2a;1a) of said tank (1) to be protected.

4. Device, according to at least one of the previous claims, **characterized in that** said external isolating layer (41) also extends to all the length of said metal tubular element (4).

5. Device, according to claim 3 or 4, **characterized in that** said electrode (3) is susceptible of connection to a current generator (5;5a;5b) supplied from any source of electromotive force, through the electrical connection of the end of said metal tubular element (4) outside to said metal tank (1) to said current generator (5;5a;5b).

6. Device, according to claim 5, **characterized in that** the electric connection of said current generator (5) to said metal tubular element (4) and said metal tank (1), respectively, is obtained through common electric connecting means (8,8.1,6;7,9,11).

7. Device, according to claim 5, **characterized in that** the electric connection of said metal tubular element (4) to said current generator (5a;5b) is obtained through means (8.1;8a;8b) apt to incise said external isolating layer (4.1).

8. Device, according to claim 5, **characterized in that** the electric connection of said metal tubular element (4) to said current generator (5a;5b) is obtained through means (8a;8b) which also act as a fast engaging support.

9. Device, according to claim 8, **characterized in that** the electric connection of said generator (5a;5b) to said flange (2;2a) is obtained by means of a flexible metal contact (9a) by simply approaching said generator (5a;5b) to said flange (2;2a).

10. Device, according to any of the previous claims, **characterized in that** said metal tubular element (4) may contain one or more devices extraneous to the protection from corrosion, said devices being in particular temperature sensors (15,15.1).

11. Device, according to any of the previous claims, **characterized in that** are provided means (4.2;13) for electric isolation of the internal surfaces of said metal tubular element (4).

12. Device, according to any of the claims 1 to 10, **characterized in that** the electric connection of said generator (5) to said metal tubular element (4) and/

or directly to said electrode (3), is obtained through temperature metal sensors means (15,15.1) housed inside of said metal tubular element (4).

**13.** Device, according to claim 12, **characterized in that** is provided an elastic metal element (16) apt for ensuring a safe electric contact between said temperature metal sensors means (15,15.1) and the internal wall of said metal tubular element (4) and/or of said electrode (3).

**14.** Device, according to claim 3, **characterized in that** the fastening of said metal tubular element (4) to said seats (2.1;2a.1;2b) of said metal portion (2;2a; 1a) of the said tank (1) to be protected is obtained with any known means apt for preserving electric isolation and ensuring water sealing too, in particular by means of a bushing of elastomeric material (12) or caulked metal bushing against said metal tubular element (4) or an expanding of said metal tubular element (4) against a seat (2a.1) or a seal.

**15.** Device, according to claim 1 or 2, **characterized in that** the fastening of said metal tubular element (4) to said seats (2.1;2a.1;2b) of said metal portion (2; 2a;1a) of said tank (1), should the electrode (3) consist of a sacrificial anode, is obtained through a welding procedure so as not to degrade the external isolating layer (4.1).

**16.** Device, according to one or more of the previous claims, **characterized in that** said external isolating layer (4.1) consists of a film of synthetic material, in particular a non porous material.

**17.** Metal container and/or tank for containing fluids, in particular an electric and/or gas storage water-heater, utilizing a device for electrochemical protection from corrosion, according to one or more of the previous claims.

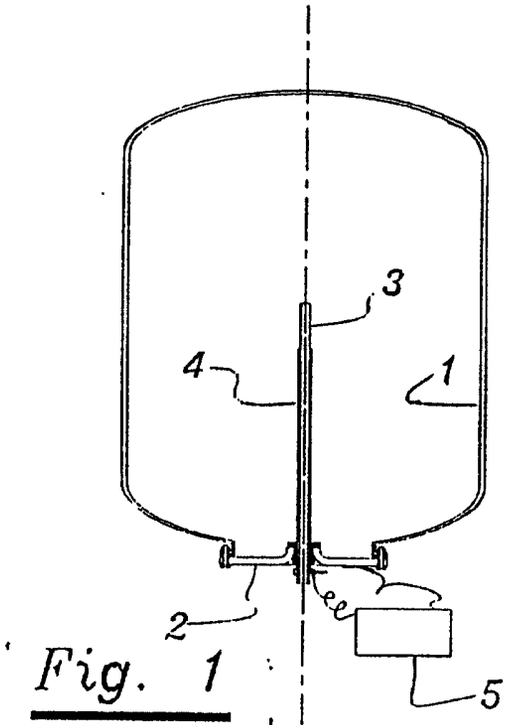


Fig. 1

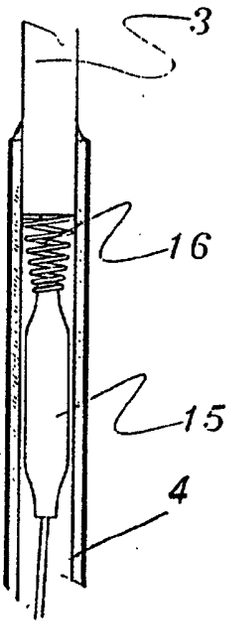


Fig. 8

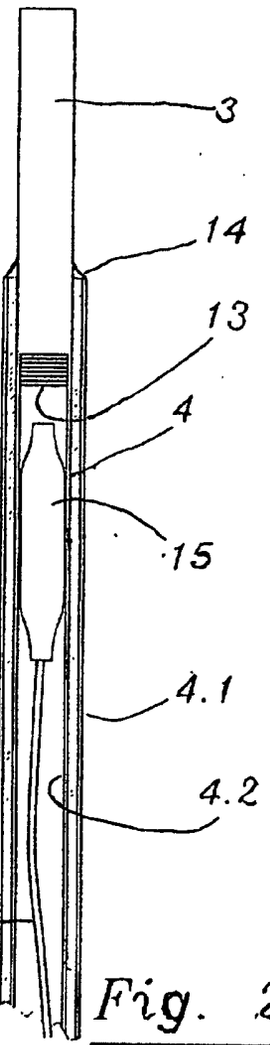


Fig. 2

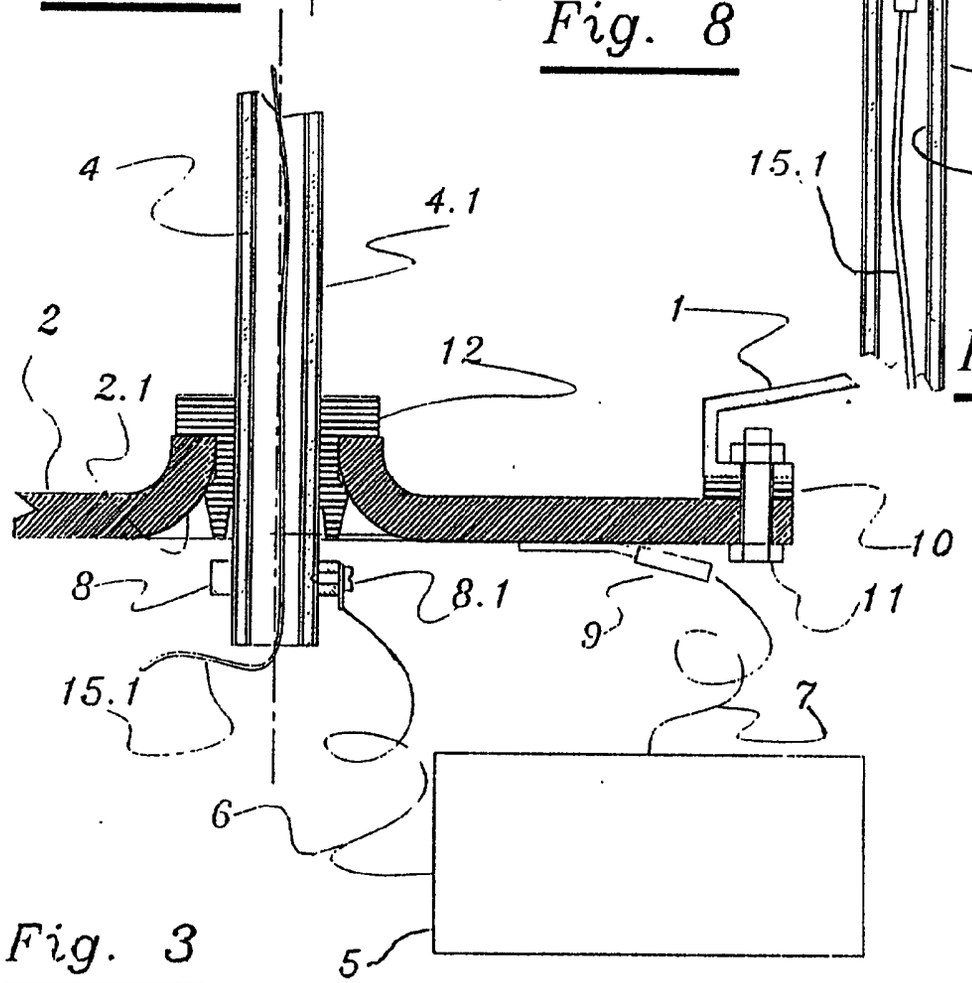


Fig. 3

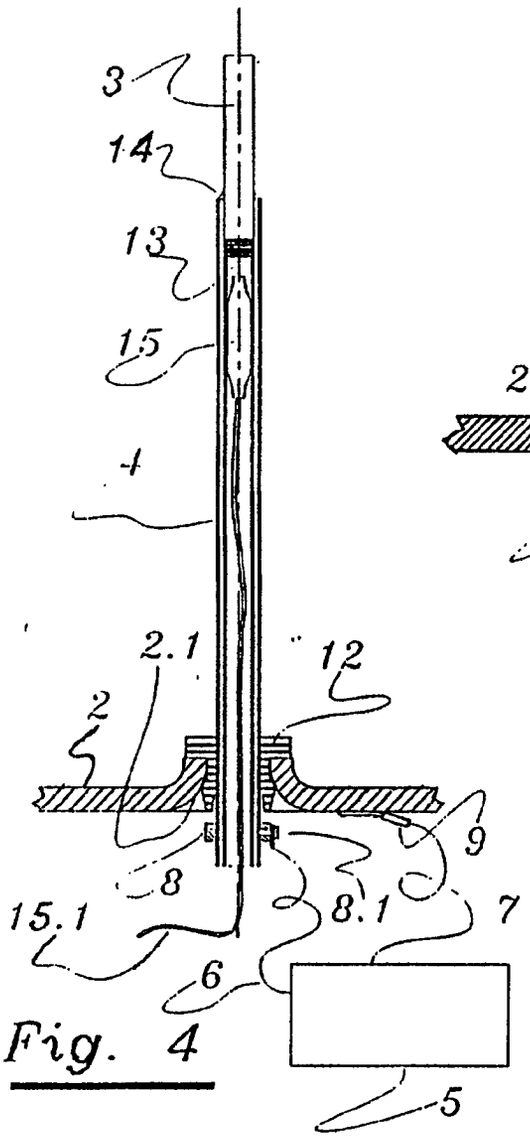


Fig. 4

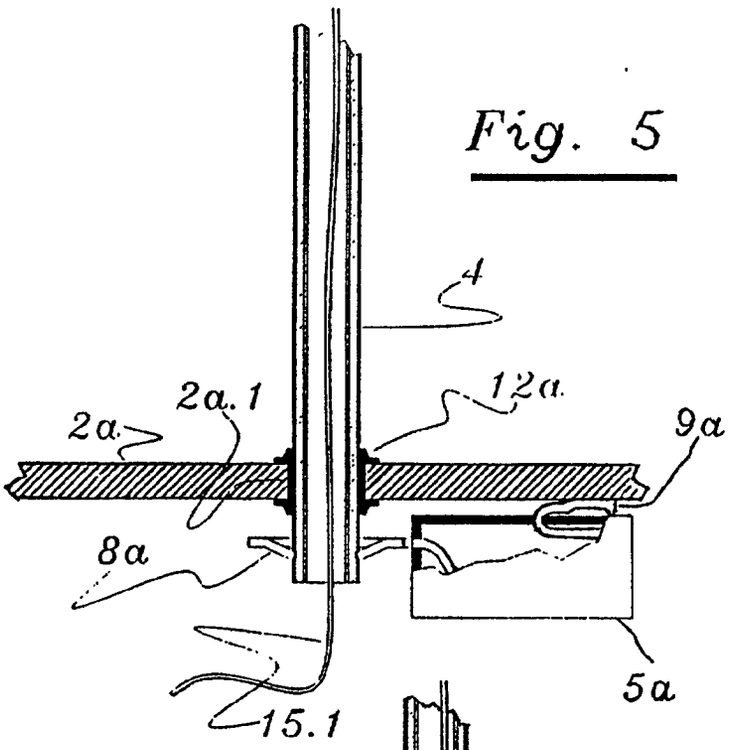


Fig. 5

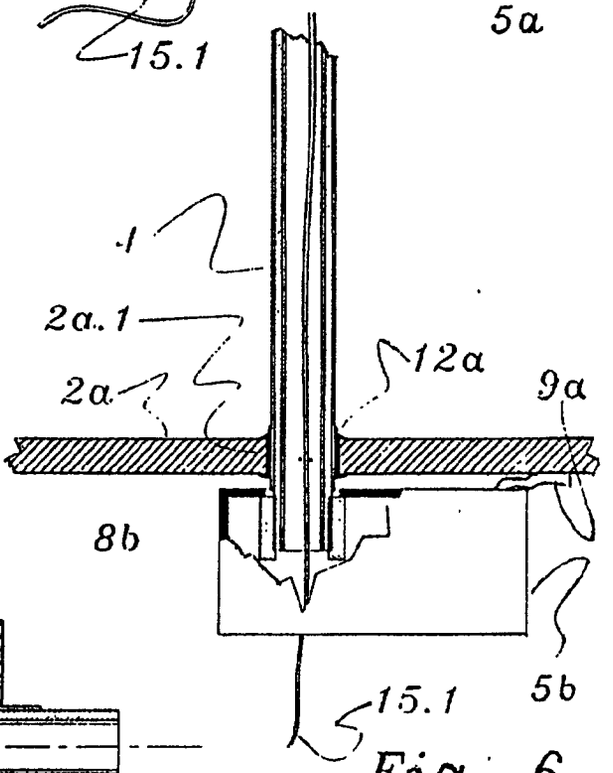


Fig. 6

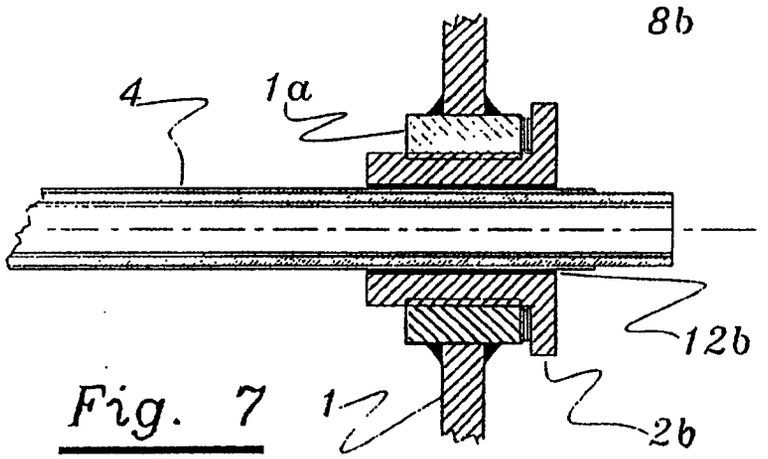


Fig. 7

European Patent Office

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Application Number
EP 00 11 5560

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