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(71) Applicant (for all designated States except US): **HEATING SYSTEM INNOVATIONS LTD** [GB/GB]; 21 St. Thomas Street, Bristol, Somerset BS1 6JS (GB).

(72) Inventors; and

(75) Inventors/Applicants (for US only): **CLAY, Michael** [GB/GB]; Heating System Innovations Limited, 21 St Thomas Street, Bristol, Somerset BS1 6JS (GB). **HARNETT, Ty** [GB/GB]; Heating System Innovations Limited, 21 St Thomas Street, Bristol, Somerset BS1 6JS (GB). **NORTHOVER, Matthew** [GB/GB]; CZQ Heating System Innovations Limited, 21 St Thomas Street, Bristol, Somerset BS1 6JS (GB).

(74) Agent: **BAILEY, Richard**; Marks & Clerk LLP, 27 Imperial Square, Cheltenham, Gloucestershire GL50 1RQ (GB).

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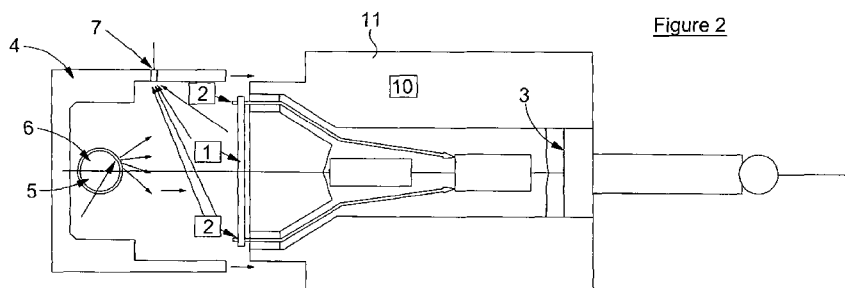


Figure 2

(57) Abstract: A method is provided of corrosion detection within a fluid handling system containing a fluid comprising the steps of: providing an element sensitive to corrosion and in contact with the fluid; electrically monitoring the continuity of the element; and automatically providing an indication of a break in continuity of the element; wherein the element is arranged to break in response to a predetermined threshold level of corrosion. An apparatus for use in the method is also described. Although not necessarily essential to the invention, the apparatus may include a cap, housing or other enclosure arranged to protect the element from particles and hydrodynamic forces while allowing sufficient fluid communication for corrosion of the element to be representative of corrosion in the fluid handling system. An assembly suitable for use in installation of the apparatus is also disclosed which makes use of self-cutting valves to allow installation without requiring drainage of the system.

Method and apparatus for corrosion monitoring

The invention relates to a method and apparatus for corrosion monitoring, for example to permit sensing of the occurrence of a predetermined level of corrosion.

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Corrosion, for example electrolytic corrosion, is a major cause of failure in systems of pipes for handling fluid, for example in wet central heating systems. Whilst this invention relates primarily to monitoring corrosion in a wet central heating system, it could also be used in, for example, industrial systems in which working fluids in pipe systems may comprise steam, hot combustion products and other corrosive substances. Over time corrosion can damage the structure of the fluid system leading to failure. For example a pipe wall or radiator may be thinned by corrosion until it mechanically fails under pressure or structural load. Deposits of corrosion can accelerate wear of mechanical components and reduce overall system efficiency.

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Central heating systems frequently employ water as a working fluid for the transport of heat. Such heating systems frequently comprise a number of different metals for example copper, aluminium, brass and steel, comprising for example pipes, heat exchangers, pumps, fittings and radiators. Electrolytic corrosion occurs due to the dissimilar metals and the presence of water which acts as an electrolyte, resulting in accelerated corrosion of less noble materials, for example steel.

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The corrosion of metal parts may lead to the build-up of sludge typically comprising iron oxide or rust. Corrosion may further damage parts or reduce their efficiency. To reduce corrosion it is known to add a corrosion inhibitor to the working fluid. This is typically a liquid comprising various chemicals that is added to the working fluid. The effect of such corrosion inhibitors may diminish over time due to degradation of the chemicals. The addition of fresh working fluid to the system, which may take place as a result of maintenance, will also tend to dilute the concentration of the corrosion inhibitor and reduce its effectiveness. It is known that damage resulting from corrosion can result in reductions in overall central heating system efficiency and can damage components and prevent them from working.

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A known technique for measuring the rate of corrosion within fluid systems is to measure the electrical resistance of a metallic element immersed in the fluid. Changes

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in the resistance of the metallic element in contact with the fluid are attributable to metal loss from the exposed element. An incremental change in resistance is proportional to an increment of corrosion. A reference resistor element which is not exposed to the fluid is typically incorporated into the probe comprising the metallic element in contact with the fluid, and the ratio of resistance of the reference and exposed element is typically measured to eliminate changes in resistance due to temperature. An example of a resistance based corrosion monitoring system is described in US3094865. Such prior art resistance based corrosion monitoring devices are directed towards providing a measurement of the rate of corrosion over a relatively short period of time.

It is known to carry out a chemical analysis of the working fluid to detect the presence of a corrosion inhibitor. Such testing cannot be used on a continuous basis, and is relatively time consuming and inconvenient to carry out. Furthermore, the chemicals used typically have a relatively short shelf life and tests carried out with degraded reagents can give inaccurate results.

US6131443 discloses a corrosion monitor that indicates when a threshold level of corrosion has taken place. A corrodible interior wall excludes fluid from an interior cavity of the monitor. The interior cavity includes a material that reacts with the fluid to indicate penetration of the corrodible wall by the fluid. An optical indication means is disclosed in which a transparent window of the interior cavity is coated with a material that changes colour when the corrodible interior wall has been penetrated by the fluid. This invention requires that the corrodible element be of sufficient thickness to survive the pressure of the fluid and this limits the minimum threshold that the device is responsive to. In addition the indication by means of a colour change could easily not be noticed due to difficult viewing conditions or a failure to actively inspect a device for colour change.

The present applicant has identified a need for a sensitive, low cost method of detecting corrosion within fluid systems. A further need has been identified by the present applicant for a more sensitive method of indicating when a predetermined threshold level of corrosion has taken place, and of providing a more obvious warning by the provision of an indicator light and audible sound.

According to a first aspect of the present invention, there is provided a method of corrosion detection within a fluid handling system containing a fluid comprising the steps of: providing an element that is sensitive to corrosion and in contact with the fluid; electrically monitoring the continuity of the element; and automatically providing an indication of a break in continuity of the element; wherein the element is arranged to break in response to a predetermined threshold level of corrosion.

According to a second aspect of the invention, there is provided an apparatus for corrosion detection within a fluid handling system containing a fluid, the apparatus comprising: a sensor housing; an element that is sensitive to corrosion and in contact with a fluid of the fluid handling system; an electrical readout circuit arranged to monitor the continuity of the element; indication means for providing an indication that the electrical readout circuit has detected a break in continuity of the element; wherein the element is arranged to break in response to a predetermined threshold level of corrosion.

The threshold level of corrosion may be arranged at a level below that at which significant damage to the components of the fluid handling system takes place.

The continuity of the element may be monitored by testing the electrical continuity of the element.

In an alternative arrangement, the element could be arranged to prevent electrical contact between electrical contacts which are resiliently biased towards one another, for example by a spring, breaking of the element resulting in electrical contact between said electrical contacts occurring and thereby providing an indication that there is a break in the continuity of the element.

The element may comprise steel or iron. The iron may be a high purity iron, for example comprising greater than 99% iron by weight.

The element may be removably attachable. The element may be held in place by magnetic force, but other means are also envisaged.

The element may be under tension. Where the electrical continuity of the element is being monitored then the tension in the element may be imparted by forces applied to the element by electrical contacts to which the element is connected. Where the element serves, when continuous, to prevent electrical contact between two electrical

contacts, then the element may be mounted upon one of the contacts and the tension imparted by forces applied by, for example, that contact.

The fluid handling system may comprise a central heating system.

The monitoring of the element may comprise automatic periodic testing.

5 A cap or other housing or enclosure may be provided to protect the element from particles and hydrodynamic forces while allowing sufficient fluid communication for corrosion of the element to be representative of corrosion in the fluid handling system. The cap or other enclosure may comprise a filter or particle separator arranged to protect the element from particles. The cap may comprise or define a flow restrictor or
10 fluid flow rate trimming device arranged to protect the element from hydrodynamic forces.

The sensor housing may comprise a standard pipe fitting for connection to a fluid system, or may be adapted to fit into a standard pipe fitting.

15 The invention also relates to an assembly for installing a device to a pipe, the assembly comprising a housing securable to the pipe and to which the device can be attached, a valve operable to control fluid communication between the pipe and a volume within the housing, the valve comprising at least one self cutting valve, operable to perforate the pipe.

The device may comprise a monitoring apparatus of the type defined hereinbefore.

20 Reference will now be made, by way of example, to the accompanying drawings, in which:

Figure 1 is a schematic diagram of a sensor assembly of a corrosion monitor according to an embodiment of the invention;

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Figure 2 is a further schematic diagram of a sensor assembly of a corrosion monitor according to an embodiment of the invention;

30 Figure 3 is a further schematic diagram of a sensor assembly of a corrosion monitor according to an embodiment of the invention;

Figure 4 is a schematic diagram of a control and readout circuit of a corrosion monitor according to an embodiment of the invention;

5 Figure 5 is a schematic diagram of an apparatus according to an embodiment of the present invention installed in a central heating system adjacent to a radiator;

Figure 6 is a schematic diagram of an apparatus according to an embodiment of the present invention installed in a central heating system adjacent to a pipe; and

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Figure 7 is a schematic diagram of a sensor housing according to an embodiment of the present invention.

15 Figure 1 and 2 are schematic diagrams of a sensor assembly 11 according to an embodiment of the present invention. A sensor element 1 is attached to electrical contacts 2 that are in turn connected to an electrical connector 3 suitable for receiving a corresponding connector 12. A cap assembly 4 is provided with a fluid inlet 5, a filter 6 and a fluid outlet 7. A sensor housing 10 is arranged to support the sensor element 1, electrical contacts 2 and electrical connector 3. A control and readout device 30 is
20 provided with test and warning LEDs 34, 35 and a test button 37.

The sensor element 1 comprises a thin metal foil or wire or other member of an electrically conductive corrodible material representative of the type of material present in the fluid system in which the device is installed, for example mild steel. The sensor
25 element 1 is electrically and mechanically connected to the electrical contacts 2. The electrical contacts 2 may be arranged to provide a tension force on the sensor element 1. The tension force may be selected to provide additional control over the corrosion predetermined threshold to which the sensor will respond. The electrical contacts 2 may be connected to the sensor element 1. The sensor element 1 may comprise a
30 thinned region in the centre and thicker, more robust regions where it is connected to the electrical contacts 2.

The sensor element 1 may be protected from corrosion and mechanical damage prior to installation by a protective coating of a material that is soluble in the working fluid.
35 The protective coating material may be water soluble and not cause damage to the

fluid system when in solution. The protective coating material may comprise sodium nitrate.

5 The sensor element 1 may be attached to the electrical contacts 2 by magnetic force, for example using high temperature capable neodymium magnets. However, other attachment techniques including the use of welding, soldering, adhesives or other techniques could be used. Alternatively the sensor element 1 may be arranged with features, for example holes, to receive the electrical contacts 2 so that the tension forces from the electrical contacts 2 tend to engage the sensor element 1 with the
10 electrical contacts 2. Other techniques for electrically connecting the sensor element 1 to the electrical contacts 2 are also envisaged. Further more, whilst as illustrated the element is under tension, this need not always be the case.

15 In an alternative embodiment, the sensor element 1 may comprise a wire, which may be wrapped around the electrical contacts 2. In a further alternative embodiment, the sensor element 1 may comprise a resistive track disposed on an insulating substrate, for example a printed circuit board, a ceramic substrate or a plastic part.

20 The electrical contacts 2 are connected to an electrical connector 3 suitable for receiving a corresponding connector 12 to allow electrical connection to be made between the with the sensor element 1 and the control and readout device 30.

25 The cap assembly 4 is arranged to be received by the sensor housing 10, for example by a screw connection, push fit or bonded connection. The cap assembly 4 protects the sensor element 1 from damage arising from particles and hydrodynamic forces, and allows appropriate fluid communication to the sensor element 1. The fluid inlet 5 is arranged with a filter 6 that separates particles from the incoming fluid. The filter is selected to separate particles that may damage the sensor element 1 when they impact upon it due to the flow of fluid around the sensor element 1. The fluid outlet 7 is
30 arranged to restrict the flow of fluid to prevent damage to the sensor element 1 arising from hydrodynamic forces. The fluid inlet 5 and fluid outlet 7 are arranged to allow fluid to flow past the sensor element 1 when the cap is assembled. A plurality of fluid inlets and outlets may be arranged in different positions on the cap.

The sensor housing 10 may be of such diameter to allow it to be fitted to a system of pipe-work or a heating component such as a radiator or boiler using a standard compression fitting. Alternatively, the sensor housing 10 may be provided with a threaded outer body and connector to allow it to be attached to a system of pipe-work or heating component.

The sensor housing 10 and cap assembly 4 may comprise a plastics material, a resin or an acrylic, or may be a ceramic or formed from another material, preferably a material that is not electrically conductive. The material of the cap may be selected to reduce the risk of particles adhering thereto, in use. Whilst this may be achieved by the use of a suitable material, it may also be possible to achieve this effect by the application of an appropriate coating to all or part of the cap. The sensor housing preferably comprises an electrically insulating material which is resistant to chemicals, for example acids, has good mechanical properties, is suitable for use at elevated temperatures such as 100 degrees C, and is able to withstand fluid pressures in excess of 6 bar. For example it may comprise an engineering plastics material.

It will be appreciated that in the arrangements described hereinbefore the sensor element 1 is electrically conductive and that its continuity is monitored by sensing whether or not a current can flow along the length of the sensor element 1. Other techniques are possible for sensing the continuity or otherwise of the sensor element 1.

Figure 3 shows a variation of the sensor assembly 11 described above in which the sensor element 1 is attached to a spring arm 9 on which is carried an electrical contact 2. The spring arm 9 urges the electrical contacts 2 together, and the corrodible sensor element 1 is connected between a fixed anchor 8 and the spring arm 9 to hold the electrical contacts 2 apart when the element is intact. The spring arm 9 and contacts 2 may preferably be made from a less-corrodible material than the element 1. The sensor element 1 may allow the spring arm 9 to close the electrical contacts 2 when the element has corroded sufficiently. The spring arm 9 imparts a tension to the sensor element 1 which may break the sensor element 1 when it has corroded sufficiently and the contacts 2 may thereupon be closed by the urging of the spring arm 9. The closure of the switch contacts 2 indicates lack of continuity in the sensor element 1. Other aspects of the sensor assembly 11 remain substantially as previously described.

Clearly, unlike the arrangements described with reference to Figures 1 and 2, the arrangement of Figure 3 operates by monitoring the mechanical integrity or continuity of the sensor element rather than monitoring its electrical integrity. The sensor element of the Figure 3 arrangement need not necessarily, therefore, be electrically conductive.

As the electrical circuit of the Figure 3 arrangement is only closed when the sensor element is no longer continuous, it will be appreciated that reductions in power consumption, and hence battery life improvements and other advantages may be achieved.

Figure 4 is a schematic diagram of a control and readout device 30 of a corrosion monitor comprising a battery 31, a programmable micro-processor 32, resistors 33 in combination with the sensor element 1, a test LED 34 and warning LED 35, a buzzer 36 and a test button 37. The control and readout device may also initiate remote monitoring via a mobile phone, building management system, PC or laptop (not shown) to provide a warning to the user. It will be appreciated that the invention is not restricted to the combination of components shown in Figure 3, and that a wide range of alterations may be made without departing from the scope of the invention.

The micro-processor 32 is arranged with a suitable program and is connected with the other circuit elements to control the operation of the corrosion monitor 20. The control and readout circuit 30 is arranged to consume the minimum amount of power to enable a very long battery life. The battery 31 preferably has a high power density and is suitable for long term low current use and conveniently comprises a lithium based primary cell. The micro-processor 32 is preferably selected to consume very little power, and is preferably arranged with a sleep mode in which minimum power is consumed. The sensor element 1 may be connected in series with resistors 33 to limit the current through the sensor element during operation.

The control and readout circuit device may be connected to the sensor assembly 11 and sensor element 1 by an electrical connector 12 that cooperates with the electrical connector 3 of the sensor assembly 11. The control and readout device may alternatively be housed within or formed integrally with the sensor assembly 11.

In use the micro-processor 32 may periodically, for instance daily, check the electrical continuity of the sensor element 1. If the sensor element 1 is still providing an electrical connection between the electrical contacts 2, the test LED 34 will flash to indicate that the test has been carried out. The micro-processor may preferably be arranged to operate in a reduced power mode between tests. If the sensor element 1 is broken and is not providing an electrical connection between the electrical contacts 2, the warning LED 35 will be flashed for a period to indicate that corrosion levels have exceeded a predetermined threshold. After the warning LED has been flashing for a period of time, for example four hours, a buzzer 36 may also be sounded intermittently.

The predetermined threshold at which the corrosion monitor 20 will provide a warning is defined by the characteristics of the sensor assembly 11, for example the thickness of the sensor element 1 and amount of tension imparted to it by the electrical contacts 2. The warning threshold of the corrosion monitor 20 is set to provide a warning of corrosion in a timely manner to allow appropriate corrective action to be taken, for example the addition of a corrosion inhibitor to the working fluid.

In addition to checking the continuity of the sensor element 1, the micro-processor 32 may periodically check the output voltage of the battery 31. If the voltage is low, an indication may be provided using the buzzer 36. An additional LED may be provided to indicate battery status. The indication of low battery voltage is arranged to be easily distinguished from the indication that the sensor element 1 has broken.

A test button 37 is provided that when pressed initiates a check of the battery voltage and electrical continuity of the sensor element 1 and the results may subsequently be indicated in the same way as for the periodic automatic tests.

Figure 5 is a schematic diagram of an apparatus according to an embodiment of the present invention installed in a central heating system. The corrosion monitor 20 comprises the connected sensor assembly 11 and control and readout device 30, and is connected to the central heating system by means of a standard fitting 24 at the return from a radiator 21. A lock shield valve 22 may be installed before the corrosion monitor 20. A control valve 23, for example a thermostatic control valve, may be fitted at the radiator inlet flow connection. This arrangement of valves allows the corrosion

monitor 20 to be isolated to facilitate maintenance or replacement and corrosion inhibitor may be conveniently introduced to the drained radiator at the same time.

5 The corrosion monitor 20 is installed in the central heating system and is exposed on a continuous basis to the working fluid of the system under the same conditions as the components of the heating system. It will be appreciated that the system does not need to be constantly monitored, and will automatically draw attention to corrosion levels above a pre-defined predetermined threshold that is set to ensure that timely corrective action is possible.

10 Figure 6 is an alternative schematic diagram of an apparatus according to an embodiment of the present invention installed in a central heating system. In this case the corrosion monitor 20 is mounted on a 'T' connector in a loop of pipe-work adjacent to a return pipe 27. Isolation valves 25 and 26 are provided to allow maintenance to be
15 conveniently carried out on the corrosion monitor 20.

Figure 7 is a schematic diagram of an assembly according to an embodiment of the present invention comprising a first housing part 50 and a second housing part 51, bolts or screws 56, or other suitable fittings, self cutting valves 52, an injection point 54,
20 a compression nut 55 and a bleed valve 59. The first housing part 50 comprises an internal channel 62 and a recess 58. The assembly is shown attached to a pipe 57 of a central heating system (the pipe being shown in broken lines in Figure 7).

The self cutting valves 52 comprise a threaded body part 63, and plunger lever 53, cutters 60 and seal elements 61 that seal the interface between the valve 52 and pipe
25 57. Further seal elements (not labelled) are included between the threaded body 63 and the first housing part 50, and between the plunger and lever 53 and the threaded body 63 at both the seat of the plunger and the stem of the lever. The lever 53 controls the position of the plunger of the valve, and may be rotated to move the plunger
30 between a position in which the valve is closed, and positions in which the valve is open.

The assembly provides a means by which a sensor element 1, carried on a sensor housing 10 may conveniently be introduced into a central heating system without the
35 need for specialist plumbing skills, and without draining any part of the heating system

of water. The assembly is installed by clamping the first 50 and second 51 housing parts around the pipe 57 using the screws 56. The pipe 57 of Figure 7 is a 22mm diameter standard copper pipe of the type typically used in central heating systems. The first housing part 50 and second housing part 51 are provided with pipe recesses that conform to the external profile of the pipe 57.

The self cutting valves 52 are either removed from the first housing part 50 prior to clamping around the pipe, or are screwed out of the housing 50 to a position in which the cutters 60 will not contact the pipe 57 when the assembly is clamped around it.

The self cutting valves 52 are then installed into the first housing part 50 by screwing the threaded body 63 of each valve fully into the first housing part 50, so that the cutter 60 perforates the pipe 57, and the seal element 61 seals the interface between the threaded body 63 of the self cutting valve 52 and the pipe 57. The self cutting valve 52, seal 61, pipe 57, first housing part 50 and second housing part 51 are arranged so that the seals function to prevent water being lost from the heating system as the cutter 60 perforates the pipe 57.

The plunger and lever 53 of each self cutting valve 52 should be in the fully closed position when the valves 52 are installed in the first housing part 50 to prevent the possibility of leaks in the event that the sensor housing has not yet been properly installed in the recess 58.

The sensor housing 10 including the sensor element 1 (not shown in Figure 7) is installed in the first housing part 50 at the recess 58 by a compression fit using the compression nut 55. A compression olive (not shown) is used to provide a seal between the sensor housing 10 and the first housing part 50. The recess 58 of the assembly is arranged to receive the sensor housing so that, in use, fluid flowing within the channel 62 will flow past the face of the sensor housing 10, thereby coming into contact with the sensor element 1.

Having installed the assembly on a pipe 57 of a central heating system, and installed the valves 52 and sensor housing 10 in the assembly, one of the valves 52 may be opened by turning the lever 53, thereby retracting the plunger from its seat. Provided a positive pressure exists with the pipe 57, water from the central heating system will

thereby be introduced to the internal channel 62 of the first housing part 50. Since the internal channel 62 is a sealed volume, air will be trapped within channel. The trapped air may be released by opening the bleed valve 59. The bleed valve 59 is arranged to ensure that substantially all the air may be removed from the internal channel 62, thereby ensuring that the face of the installed sensor housing and the sensor element are in contact with the water, and preventing air being introduced to the heating system.

Having removed the air from the internal channel 62, a second valve 52 may be opened. When water is flowing through the pipe 57, a slight pressure gradient will exist along the length of the pipe resulting in a pressure difference between the inlets of the valves 52 of the installed assembly. A flow through the channel 62 results from such a pressure difference, circulating the water of the central heating system past the sensor element 1 so that it is in contact with a flow of water representative of the corrosion environment for other parts of the heating system.

The valves 52 may be used to isolate the channel 62 of the assembly at any time, for instance when the sensor element 1 needs to be replaced. With the channel 62 isolated from the central heating system, little or no water will leak from the system when the sensor housing 10 is removed from the recess 58. When a new sensor element 1 has been installed and the sensor housing 10 replaced, the assembly may be bled of any air using the bleed valve 59, and the valves 52 opened again.

If fluids need to be added to the central heating system, for example in the case that corrosion inhibitor needs to be added in response to a warning from the corrosion detection apparatus, it may be introduced via the injection point 54. The injection point 54 comprises a non-return valve through which fluid may be added to the central heating system.

Although an embodiment of the assembly comprising two self cutting valves has been described hereinbefore, it will be appreciated that an assembly with a single isolating valve which is not self cutting may be used to isolate the sensor housing 10 to facilitate convenient replacement of the sensor element 1. It will further be appreciated that the use of two valves which are not self cutting may be used to facilitate a flow past the

sensor in a similar arrangement to that shown in Figure 7, but which is connected into a heating system using conventional plumbing fittings and methods.

It will be appreciated that the invention provides a low cost, convenient method and apparatus for corrosion detection. More specifically the invention provides for an obvious indication that remedial action is required to prevent fluid systems from suffering significant damage from corrosion. Prior art approaches have generally been directed towards providing a measurement of the rate of corrosion, and therefore required constant monitoring to indicate that a threshold had been reached. Known predetermined threshold based corrosion indicators are limited in their sensitivity and do not provide sufficiently obvious indication. The present invention overcomes these limitations.

The combination of a simple read-out circuit with very low power demand and the provision of a high power density primary cell results in a system that may operate to monitor corrosion over a considerable period of time without intervention, for example with years between battery changing.

It will further be appreciated that providing an assembly with a valve to control fluid communication with the sensor element allows the sensor element to be conveniently replaced. Providing an assembly with self cutting valves allows the sensor to be introduced to the central heating system without draining the system by a person who is not skilled in plumbing, and without the need for specialist tools. Providing two valves results in the potential for flow through the assembly past the sensor element in a manner which is representative of the corrosion environment of the parts to be protected. Little or no water loss takes place on installing the assembly, and no air is introduced to the system. Replacement of the sensor is very simple, requiring only a few minutes.

Whilst the arrangement shown in Figure 7 is particularly suitable for use in the installation and support of a corrosion monitoring device, it will be appreciated that it may be used in other applications. For example, devices other than a corrosion monitoring device may be installed in a central heating system or other piped fluid system using the arrangement of Figure 7. Furthermore, although one specific form of arrangement is shown in Figure 7, it will be appreciated that it may be modified without

departing from the scope of the invention. For example, the air bleed and/or inlet device may be omitted, and the forms of the self cutting valves may be modified.

5 It will be appreciated by the person of skill in the art that various modifications may be made to the above described embodiments without departing from the scope of the present invention.

CLAIMS:

1. A method of corrosion detection within a fluid handling system containing a fluid comprising the steps of:

- 5 providing an element that is sensitive to corrosion and in contact with the fluid;
- electrically monitoring the continuity of the element; and
- automatically providing an indication of a break in continuity of the element;
- wherein
- the element is arranged to break in response to a predetermined threshold level
- 10 of corrosion.

2. The method of claim 1 in which the continuity of the element is monitored by testing the electrical continuity of the element

3. The method of claim 1 in which the element is arranged to prevent electrical contact between electrical contacts which are urged together by a spring, and in which
- 15 breaking of the element results in electrical contact between said electrical contacts thereby indicating lack of continuity in the element.

4. The method of any preceding claim in which the predetermined threshold level of corrosion is arranged at a level below that at which significant damage to the components of the fluid handling system takes place.

- 20 5. The method of claim 2 in which the element is mechanically and electrically connected to electrical contacts by magnetic force.

6. The method of any preceding claim in which the element comprises steel or iron.

7. The method of any preceding claim in which the element is under tension.

- 25 8. The method of claim 7 in which the element is connected to electrical contacts and the tension is imparted by forces applied to the element by the electrical contacts.

9. The method of any preceding claim wherein the fluid handling system comprises a central heating system.

10. The method of any preceding claim wherein the monitoring of the element comprises automatic periodic testing.

11. The method of any preceding claim wherein an assembly comprising an interior volume and a valve is provided, wherein the element is mounted within the interior volume, and the valve is used to control fluid communication with the element.

12. The method of claim 11 wherein the valve is a self cutting valve, and the self cutting valve is used to perforate the fluid handling system to make a fluid connection between the fluid system and the interior volume.

13. The method of claim 11 or 12 wherein the assembly further comprises a bleed valve which is used to release gas from the interior volume.

14. The method of any of claims 11 to 13 wherein the assembly further comprises an injection point through which further fluid is introduced into the fluid of the fluid handling system.

15. The method according to any of the preceding claims, further comprising providing protection means to protect or reduce the risk of damage to the element arising from at least one of the application of hydrodynamic forces, particle impact and erosion.

16. The method according to Claim 15, wherein the protection means comprises a cap, housing or the like.

17. Apparatus for corrosion detection within a fluid handling system containing a fluid, the apparatus comprising:

a sensor housing;

an element that is sensitive to corrosion and in contact with a fluid of the fluid handling system;

an electrical readout circuit arranged to monitor the continuity of the element;

indication means for providing an indication that the electrical readout circuit has detected a break in continuity of the element; wherein

the element is arranged to break in response to a predetermined threshold level of corrosion.

18. The apparatus of claim 17 in which the electrical readout circuit monitors the electrical continuity of the element.

5 19. The apparatus of claim 18 in which the electrical readout circuit comprises electrical contacts which are urged together by a spring, with the element arranged to prevent electrical contact between said electrical contacts, and in which breaking of the element results in electrical contact between said electrical contacts.

20. The apparatus of claim 17 in which the element is under tension.

10 21. The apparatus of claim 20 in which the element is connected to at least one electrical contact and tension is imparted to the element by forces applied to the element by the electrical contacts.

15 22. The apparatus of claim 17 to 21 in which the predetermined threshold level of corrosion is arranged at a level below that at which significant damage to the components of the fluid handling system takes place.

23. The apparatus of claim 17 to 22 in which a cap, housing or other enclosure is provided to protect the element from particles and hydrodynamic forces while allowing sufficient fluid communication for corrosion of the element to be representative of corrosion in the fluid handling system.

20 24. The apparatus of claim 23 in which the cap or the like comprises or defines a filter arranged to protect the element from particles.

25. The apparatus of claim 23 or 24 in which the cap or the like comprises a flow restriction arranged to protect the element from hydrodynamic forces.

25 26. The apparatus of claims 17 to 25 in which the element comprises a high purity iron or steel

27. The apparatus of claim 26 in which the element is held in place by magnetic force.

28. The apparatus of claims 17 to 26 in which the element is removably attachable.

29. The apparatus of claims 17 to 28 in which the sensor housing comprises a standard pipe fitting for connection to a fluid system.

30. The apparatus of any claims 17 to 29 further comprising an assembly arranged to receive the sensor housing and comprising a valve, operable to control fluid communication with the element when the sensor housing is received within the assembly.

31. The apparatus of claim 30 wherein the valve is a self cutting valve, arranged to perforate a pipe of the fluid handling system.

32. The apparatus of claim 31 wherein the assembly is provided with seal elements, arranged to seal the interface between the assembly and the pipe as the self cutting valve perforates the pipe.

33. The apparatus of any of claims 30 to 32 comprising two valves, wherein each valve has an inlet arranged, in use, to communicate with the fluid system and wherein the valves are arranged to provide fluid flow past the element when a pressure difference exists between the two valve inlets.

34. The apparatus of any of claims 30 to 33 wherein the assembly comprises a bleed valve through which gas may be released from within the assembly.

35. The method of any of claims 30 to 34 wherein the assembly comprises an injection point comprising a non-return valve, through which further fluid may be introduced into the fluid of the fluid handling system.

36. An assembly for installing a device to a pipe, the assembly comprising a housing securable to the pipe and to which the device can be attached, a valve operable to control fluid communication between the pipe and a volume within the housing, the valve comprising at least one self cutting valve, operable to perforate the pipe.

37. The assembly of claim 36, further comprising seal elements, arranged to seal the interface between the housing and the pipe as the self cutting valve perforates the pipe.

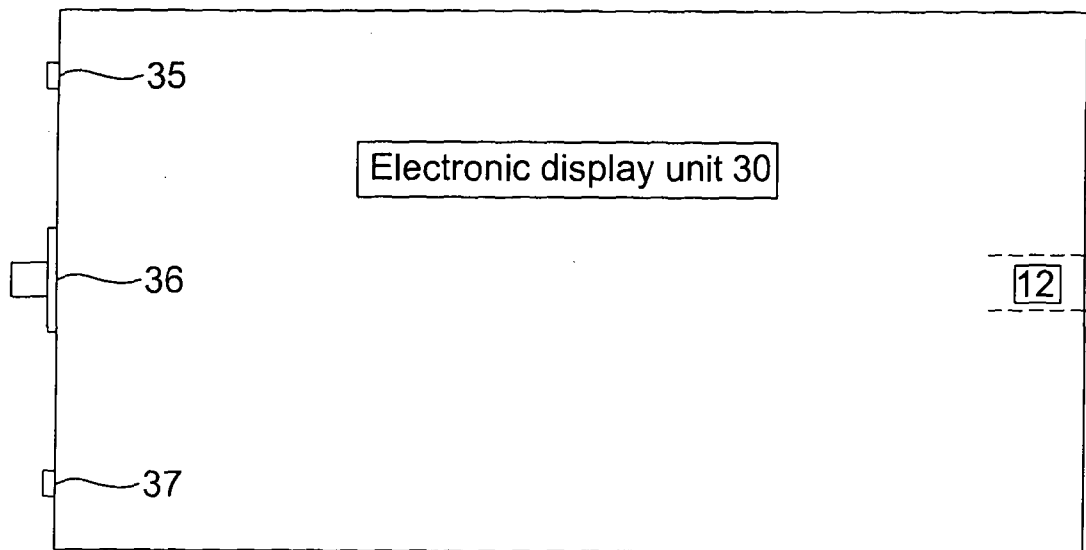


Figure 1

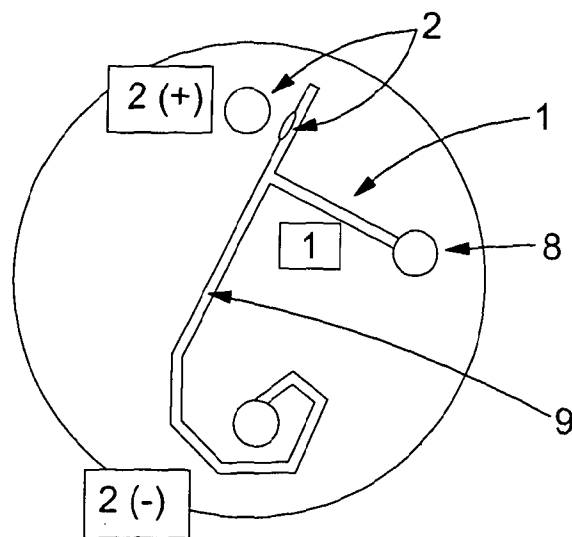


Figure 3

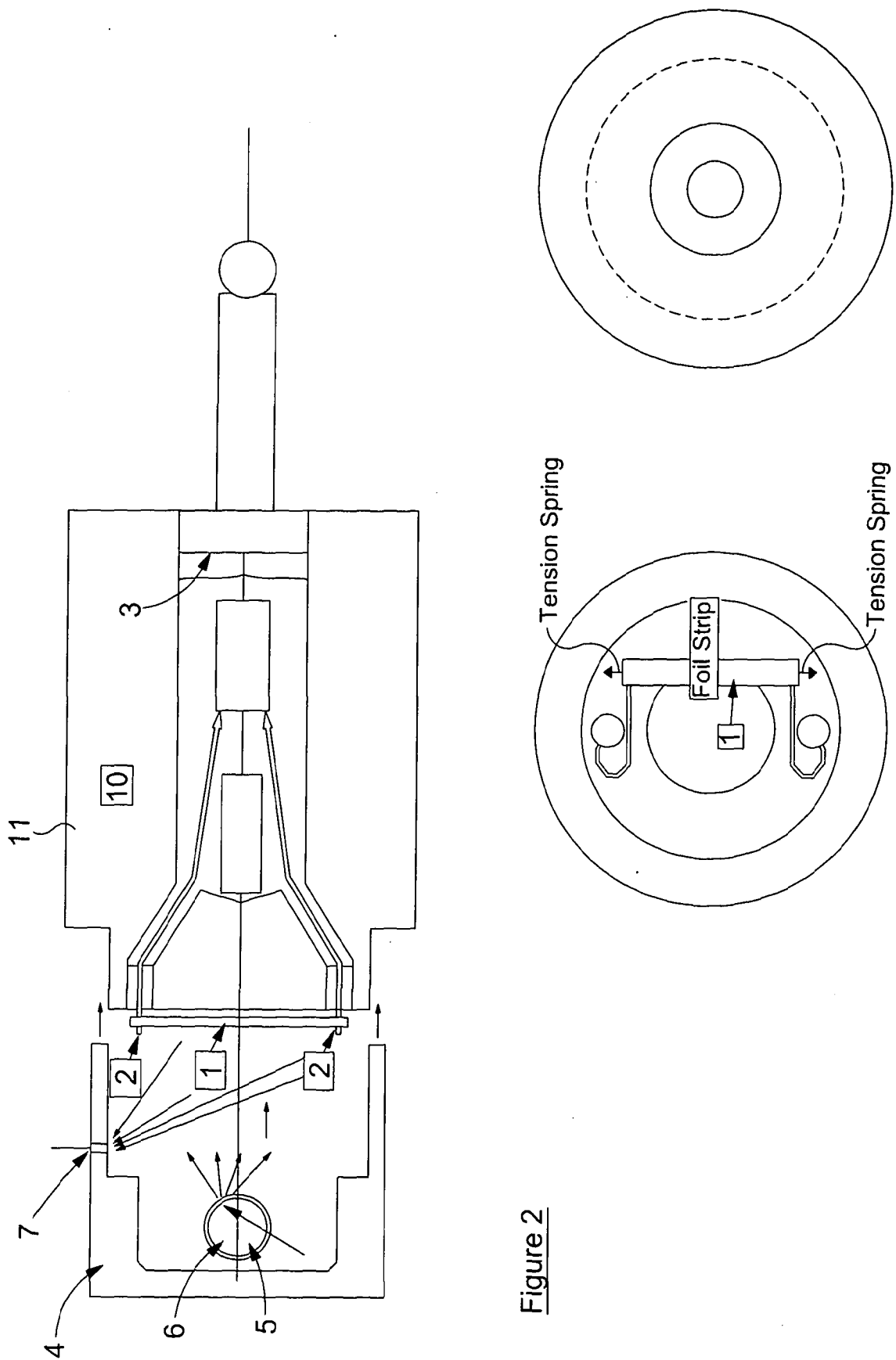


Figure 2

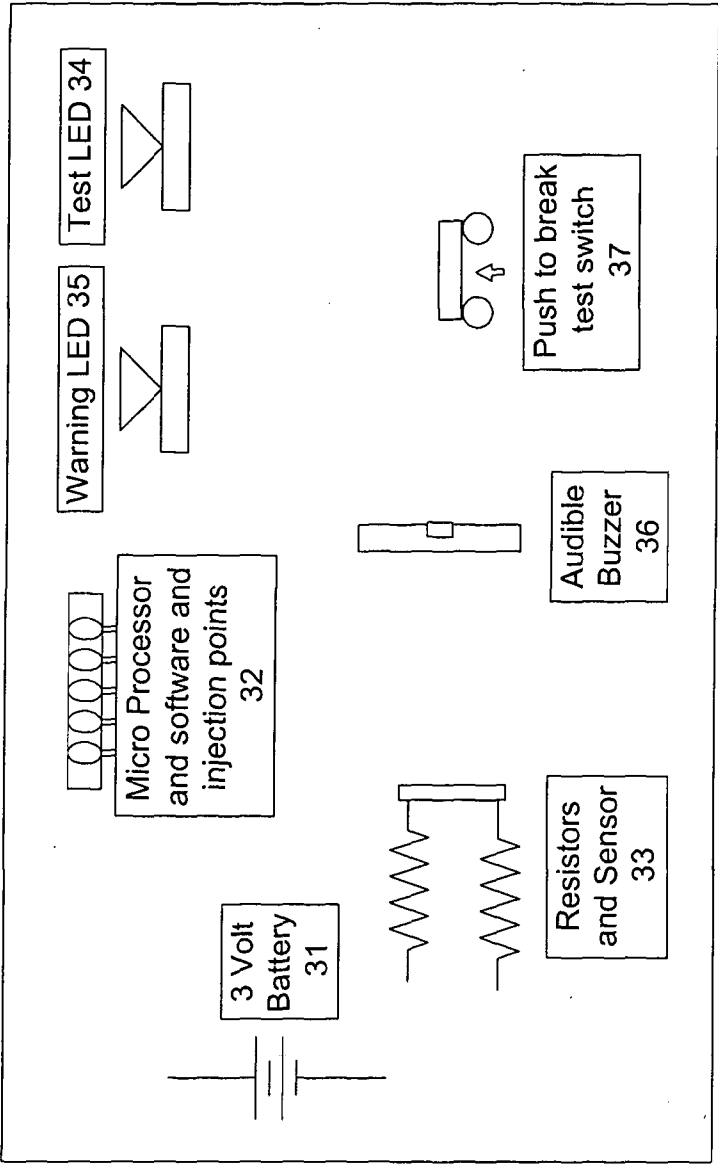


Figure 4

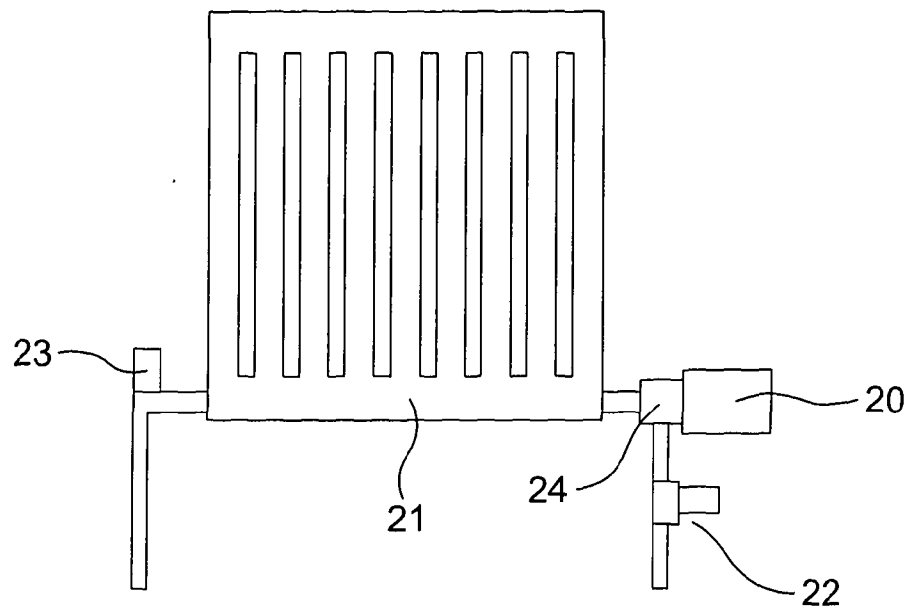


Figure 5

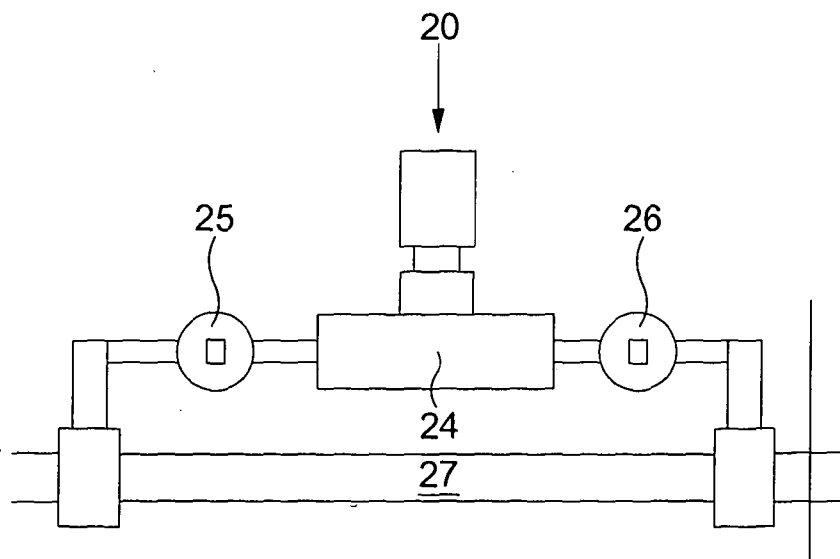


Figure 6

Diagram of self cutting valve assembly for easy fitting of Rust Informer sensor

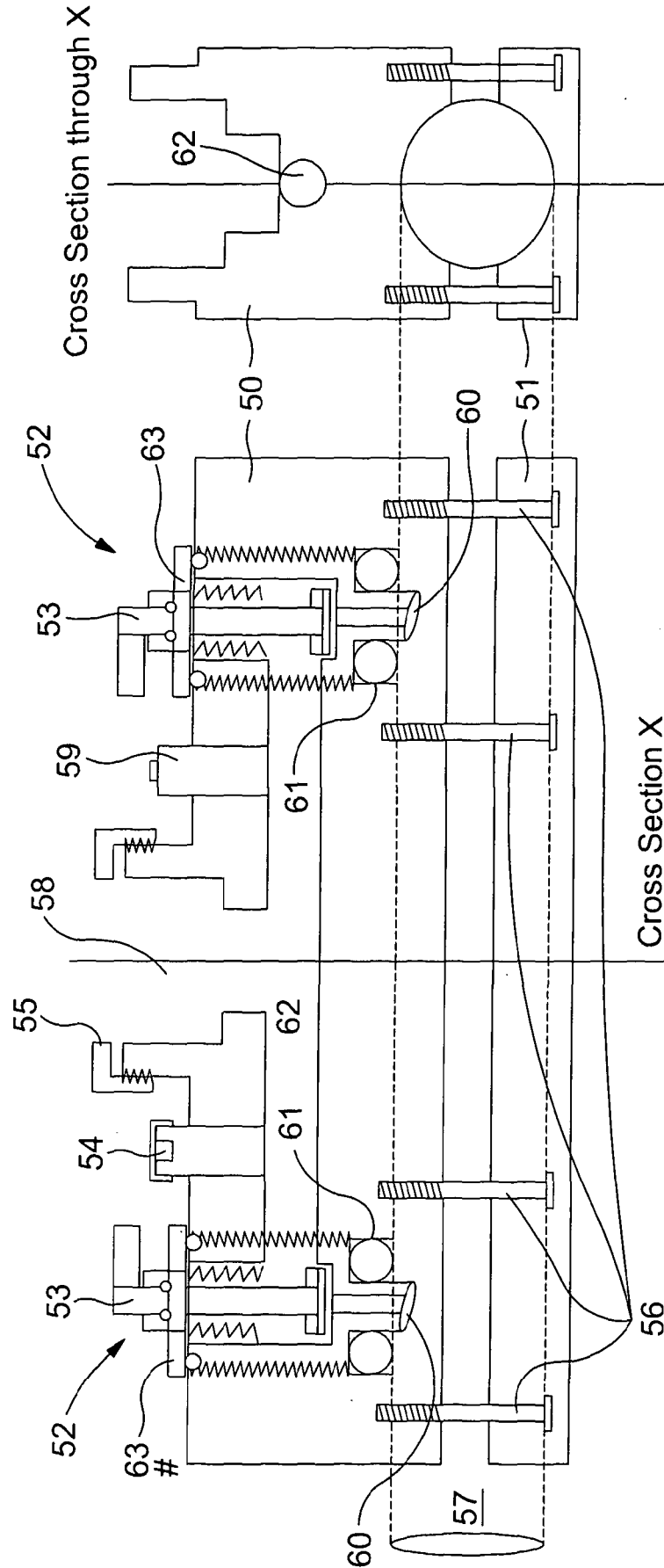


Figure 7