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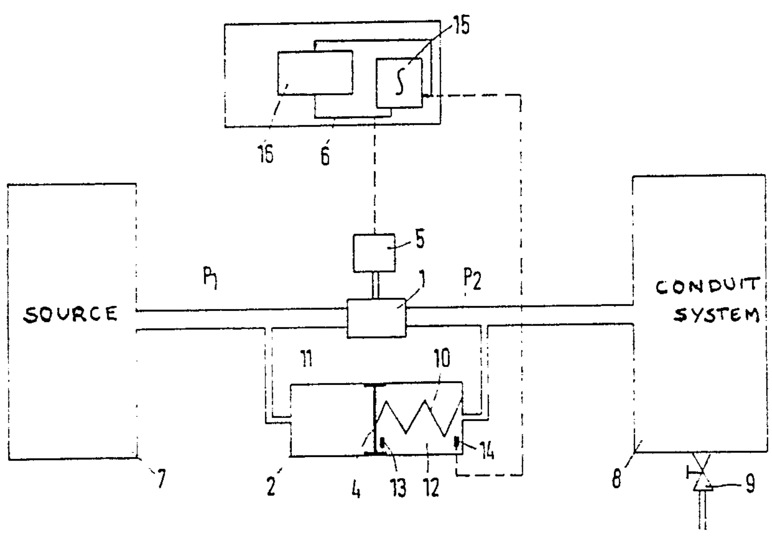
(54) **Method and apparatus for monitoring for leaks**

(57) Leaks in a conduit system for incompressible fluid are monitored by introducing test fluid into the conduit system 8 without increasing the conduit pressure during a test period when no fluid is being withdrawn from the conduit system and the conduit system is closed-off on the supply side by a main valve 1. To introduce fluid without increasing the pressure and without the entry of test fluid from the supply side of the main valve (1), a cylinder 2 divided by a spring biased wall 4 into two chambers 11 and 12 is connected to either side of the valve1. With valve 1 open and taps 9 closed, the pressures P1 and P2 on either side of valve 1 and movable wall 4 are equal and spring 10 moves wall to the left hand end of cylinder 2. On the extreme left hand position sensor 14 via control means 6 closes valve 1. If there is a leak, the pressure P2 in the conduit will decrease and the wall 4 will be moved to the right by the mains pressure P1 and force the volume of fluid into the conduit system 8. The time for this predetermined volume of fluid to be delivered to the conduit system is measured using sensor 13, 14. The sensor causes reopening of the valve 1 and a repeat of the above measuring sequence. Instantaneous flow rate and total volume of leaking fluid help decide whether the leak is such that shut down is required.



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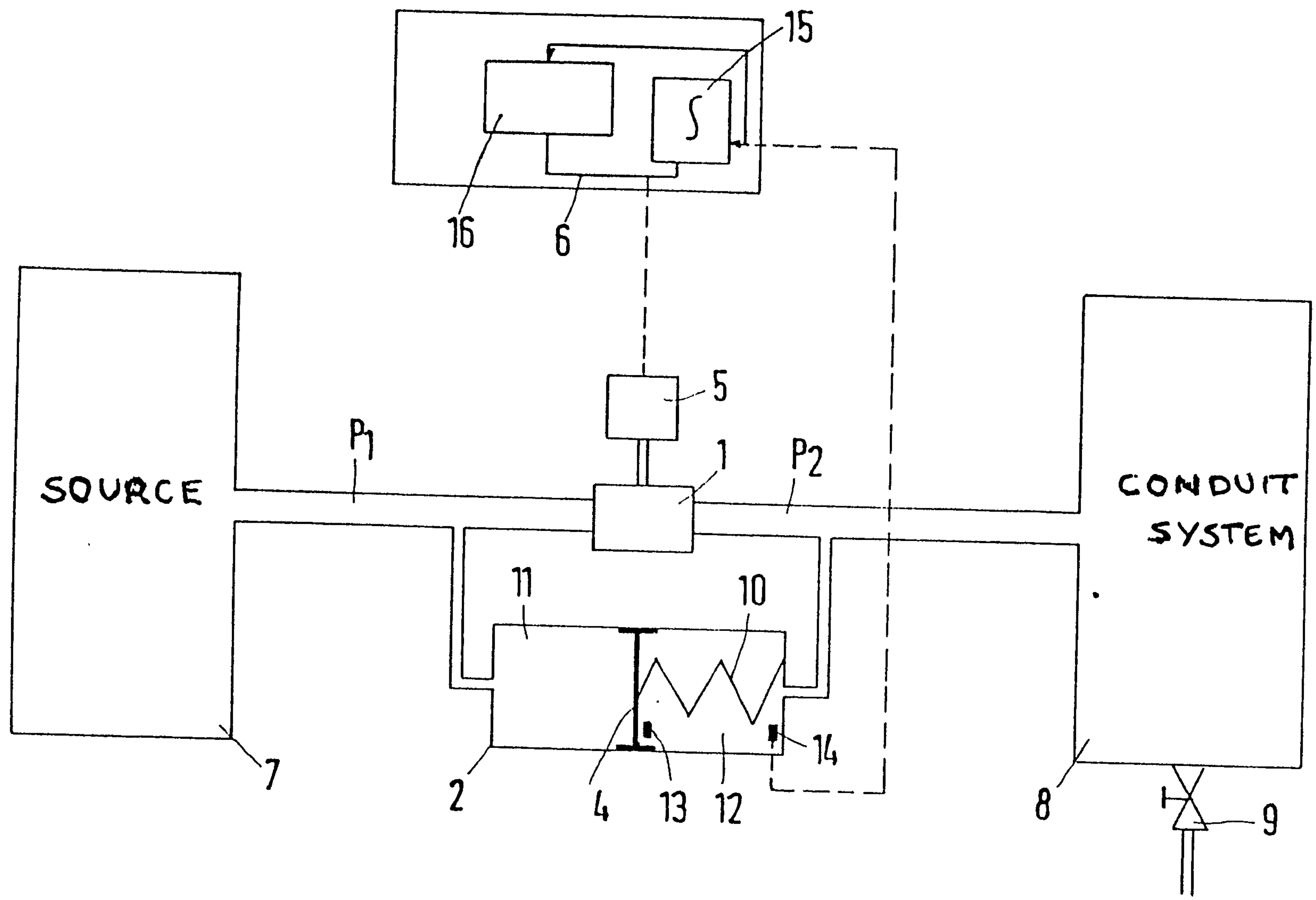
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SOURCE
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CONDUIT SYSTEM
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Method and apparatus for monitoring for leaks

This invention relates to methods and apparatus for monitoring for leaks conduit systems for incompressible fluid. More particularly, the invention relates to a method of monitoring for leaks a conduit system for an incompressible fluid, in which test fluid is introduced into the conduit system during a test period when no fluid is being withdrawn from the conduit system and the conduit system is closed off on the supply side by a main valve, and to apparatus for monitoring for leaks a conduit system for incompressible fluid, the apparatus comprising a main valve for connection on the supply side of the conduit system, and control means for controlling the operation of the main valve.

Fluid conduit systems have to be monitored for imperfectly sealed joints and leaks. That applies fundamentally to all conduit systems, regardless of whether they are employed to convey mains water into a house, heating liquids in heating systems with either a local or remote source of heat, or gases or fuels in distribution circuits.

The monitoring of mains water in buildings has, in particular, increased in importance in recent years. The problem which underlies the invention will be explained by using the example of a mains water installation in a residential building. Normally, the consumption of water through drawing-off by a user from a water tap amounts to between about 50 and 1500 litres per hour. In extreme cases, for example, flush cisterns of water closets or a washing machine, the consumption can even be from 30 to 2500 litres per hour. Leakages attributable to a broken pipe or the bursting of a supply hose for a washing machine or a dishwasher are typically in the range of 500 to 2500 litres per hour, sometimes more, (such leakages will here be called "major leaks") and cannot therefore be distinguished from normal consumption on the basis of volume flowrate alone. For that reason, the supply of water is to be interrupted when such a flowrate above a predetermined value exists after a predetermined draw-off time regardless of whether a user is using the water or there is a major leak.

To be distinguished from the above, are faults referred to herein as "minor leaks". In this case, the loss of water is in the range of about 1 to 25 litres per hour and can, on the one hand, be caused by dripping water taps and overflowing water closet cisterns, and, on the other hand, by imperfectly sealed pipe connections, the commencement of fatigue failure in pipes as a result of corrosion, hairline fractures in pipes and vessels or similar damage in the conduit system. Whereas the first set of examples may not be dangerous but merely increase the costs of fresh water and drainage and place an extra load on drinking water sources and thus on the environment, minor leaks of the second kind can cause considerable damage. More particularly, the quantity, of 1 to 25 litres per hour, flowing out of the system may appear to be very small but, over a prolonged period, walls or other parts of a building can get beyond repair as a result of becoming thoroughly soaked. The resulting damage is often noticed too late because the dampness starts inside a wall and does not become visible until the whole wall is saturated. If one were to discover such a minor leak at an early stage, then a timely repair could be carried out.

In International patent publication WO 87/04520, an arrangement is disclosed for checking a central heating system for leakage. That arrangement consists of two flowmeters of the vane-wheel type in the supply and return conduits of the system. Each vane-wheel flowmeter determines the total volume flowing through the heating system. If there is no leak, then the two measured volumes must be the same. If there is a difference between the two measured volumes, then a leak is suspected and the circuit is shut down by way of a motor valve. Since, however, the volumetric flowmeters are provided in the main flow, that is to say for large volume flowrates, they are unable to detect minor leaks below, say, 25 litres per hour with the required degree of accuracy.

International patent publication WO 86/06457 discloses equipment for monitoring pressurized conduits for points of leakage, the equipment measuring the pressure in the conduit system downstream of the main valve and closing off the main valve either when a large amount of fluid flows through the main valve for a prolonged period or, if the main valve is closed, the period required for the pressure to drop from a first pressure to a second pressure is less than a permitted time interval. Since, however, the pressure on the supply side of the main valve varies considerably, for example, pressure fluctuations at the waterworks that may be of the order of 1.2 bar, or as a result of suddenly occurring usage in an adjoining conduit system, where the pressure might drop by about 0.6 bar and, on termination of that usage, rise about 0.4 bar above the normal waterworks pressure, and because of the pressure drop across the main valve as a result of usage in the conduit system being monitored, unsatisfactory results only can be achieved wiht the pressure measurement technique disclosed in publication WO 86/06457.

German patent specification DE-OS 21 58 901 discloses an apparatus for monitoring installations for fluid-tightness. When no fluid is being drawn-off, a leak is detected by withdrawing compressible fluid from the source, for example, the supply mains, upstream of the main valve, compressing the withdrawn fluid with a compressor, and feeding the compressed fluid into the conduit system downstream of the main valve. After reaching a test pressure, the compressor is shut off. One now examines whether the pressure does not exceed a predetermined value within a predetermined time period. In a different embodiment described in that specification, one checks whether the compressor can build up the required test pressure during a predetermined running time. Since the volume put out by the compressor always depends on the pressure difference between the inlet and the outlet of the compressor, it is practically impossible to come to any conclusion about the quantity put out unless in addition the two pressures are monitored. The known equipment is therefore suitable only for determining whether there is a leak or not. One cannot say how large this leak might be. In addition, a separate means of powering the compressor is required and that can, also, lead to undesirable noise. After detecting a leak, the main valve is locked in the closed position but fluid can nevertheless penetrate into the conduit system by way of the compressor and continue to escape through the leak.

It is the problem underlying the invention to provide a method and apparatus with which even small leaks can be detected reliably.

The present invention provides a method of monitoring for leaks a conduit system for an incompressible fluid, in which test fluid is introduced into the conduit system during a test period when no fluid is being withdrawn from the conduit system and the conduit system is closed off on the supply side by a main valve, wherein a leak is detected by the introduction, without the entry of test fluid from the supply side of the main valve, of a predetermined test volume of test fluid under pressure and monitoring of the time required for the test volume to flow into the conduit system.

The above-mentioned problem is solved by the feature that a leak is detected by the introduction, without the entry of test fluid from the supply side of the main valve, of a predetermined test volume of test fluid under pressure and monitoring of the time required for the test volume to flow into the conduit system.

During testing, virtually exactly the same amount of fluid leaves through the point of leakage as during normal operation. Since that escaping fluid is immediately replenished, the leakage volume flowrate can be measured substantially exactly if one can assume that it does not fluctuate appreciably over a period of time. The volume flowrate is determined simply by dividing the known test volume, that is the replenished quantity, by the measured time. In addition, a substantially constant pressure is maintained because of the replenishment by the test fluid of the conduit system being monitored, whereby a sufficient amount of fluid is available immediately on commencement of usage.

In one embodiment, the pressure under which the test fluid is introduced into the conduit system is of the same order of magnitude as the fluid pressure on the supply side of the valve. Preferably, the pressure under which the test fluid is introduced into the conduit system is approximately the same as the fluid pressure on the supply side of the valve. In one known apparatus, an increase in pressure is required which can make worse a leak caused by a weakness of the material of a conduit. Thus, in the present case, no excess pressure is applied in order to detect a leak but test fluid is introduced into the conduit system under normal pressure. Since the normal pressure, that is, the supply pressure of the mains, for example, the water mains of a city, is applied to any points of leakage when the main valve is open, replenishment of the test volume under substantially the same pressure can preactically reproduce the escape of leakage fluid under normal (as opposed to test) conditions. Since excessive pressure is avoided, the conduit system to be monitored is not stressed any more intensively than during normal operation.

Preferably, the test fluid is drawn from the conduit system before the test period. Thus, for test purposes, exactly the same fluid is employed as that which is normally distributed by the conduit system being monitored. No special test fluid has to be provided and that makes the method considerably cheaper. Accordingly, all of the test fluid that is employed has already passed through the main valve and any upstream meter so that no difficulties are encountered, for example, with the waterworks when reckoning the mains water consumption. Moreover, no additional filters or like equipment have to be provided for the test fluid. Since the withdrawal of the test fluid takes place immediately prior to the test period, it is also practically virtually impossible for any error to occur because of a time difference between withdrawal of the test fluid and the test period.

Advantageously, the test volume is less than 0.5 litres. Even the largest test volume of 500 cubic centimetres of this preferred limit is still relatively small; such a volume would fill a cylinder merely about 8 centimetres in diameter and 10 centimetres high. This small test volume reduces the manufacturing costs and very considerably reduces the space taken up by the test apparatus. The smaller the test volume, the higher will be the resolution for the time measurement.

Preferably, after the completion of introduction of a test volume of test fluid, a further test volume of test fluid is again drawn from the conduit system and retained available for introduction into the conduit system for leakage monitoring at a later time. That makes continued measurement of the leakage volume possible. The progress with time of the leakage volume flowrate can thus be better monitored.

Preferably, the method includes determining the total volume of test fluid introduced by adding individually introduced volumes. That not only gives an indication of the particular individual leakage volume flowrate but also determines the quantity of the total escaped fluid as an additional parameter for consideration.

It is also advantageous for the method to include making a continual determination of the leakage volumetric flowrate. That enables rapid recognition of a change in the leakage behaviour of the conduit system being monitored and hence suitable protective or counter-measures can be taken in good time.

Preferably, the method includes producing an alarm signal when the total volume of test fluid introduced exceeds a predetermined first value and/or the leakage volumetric flowrate lies between a predetermined first and a predetermined second value.

The alarm may be a light or sound signal. To set-off the alarm, two criteria are thus availabnle, namely, on the one hand, the total volume that has escaped at the point of leakage, and, on the other hand, the current leakage volume flowrate. If the actual leakage volume flowrate lies below a certain limit, for example, 1 litre per hour, the system is considered to be leakfree. With a leakage volume flowrate between, for example, 1 litre per hour and 3 litres per hour, a minor leak is assumed which, although it needs to be monitored, will not cause much damage. With a leakage volume flowrate between, for example, 3 litres per hour and 20 litres per hour, one assumes a large minor leak which could give rise to serious damage. The arrangement can be such that, for example, a small minor leak is indicated immediately. Such a leak could, however, be indicated merely when the amount escaped through the small minor leak has exceeded a predetermined first value.

Preferably, the supply of fluid to the conduit system is interrupted completely if the total volume of test fluid introduced exceeds a predetermined second value. Irrespective of the size of the leak, an escaped quantity of water can present a serious danger to the building and therefore it is better to close the main valve completely in order to avoid further damage. Naturally, shutting-down can also be made dependent on the actual leakage volume flowrate.

In a preferred embodiment, the monitored total value of test fluid introduced is reset to zero if the leakage volumetric flowrate is reduced by a predetermined amount. It can, for example, happen that the leak is caused by a dripping water tap which the user failed to turn-off completely. When the user notices his or her mistake and turns off the water tap, the leak will disappear too. In that case, it is sensible to correct the total volume that was assumed to have escaped into the wall from a faulty point in the conduit system. That will then enable one to work with realistic parameters during the next test period.

The invention also provides apparatus for monitoring for leaks a conduit system for incompressible fluid, the apparatus comprising a main valve for connection on the supply side of the conduit system, and control means for controlling the operation of the main valve, wherein a chamber, communicating, in use, only with the conduit system is provided for introducing a predetermined test volume of test fluid, the chamber having a volume capacity alterable between a predetermined first, larger, value and a predetermined second, smaller, value, and time monitoring means are provided for measuring the time taken for the chamber to reduce from the first volume to the second volume.

The above-mentioned problem is solved by the features that a chamber, communicating, in use, only with the conduit system is provided for introducing a predetermined test volume of test fluid, the chamber having a volume capacity alterable between a predetermined first, larger, value and a predetermined second, smaller, value, and time monitoring means are provided for measuring the time taken for the chamber to reduce from the first volume to the second volume.

Thus, the chamber serves as a store for test fluid withdrawn from the conduit system. Since the chamber can assume two end conditions, namely, one with a larger volume and one with a smaller volume, during the time period between these two conditions it must be the exact difference in volume that has flowed out of the chamber into the conduit system or out of the conduit system into the chamber. Since the chamber communicates only with the conduit system and not with the supply side of the main valve, everything flowing out of or into the chamber must also flow through the conduit system. Since outflow from the chamber for test purposes takes place only with the main valve closed and without any pressure increase in the conduit system, the chamber introduces exactly as much fluid into the conduit system as escapes from the conduit system through a point of leakage. The time monitoring means measure the time required by the test fluid to flow into the conduit system. In other words, the time monitoring means measures the time required for a certain volume to flow out of the conduit system through the point of leakage. That enables one to obtain an indication regarding the current leakage volume flowrate on the assumption that that flow is not subjected to marked variations with time.

Preferably, the chamber has one side closed by a movable wall. The chamber is sealed at all sides with the exception of the opening to the conduit system, the volume of the chamber being changeable by the wall. The volume therefore changes linearly with the displacement of the wall which makes the evaluation simple.

Preferably, the wall is movable against the force of a spring in the direction of movement leading to the smaller value of volume. If the same pressures obtain on both sides of the wall, the spring will move the wall so that the chamber will assume its largest volume. The spring therefore assists resetting.

Preferably, the movable wall is subjected on the side remote from the chamber to a force which is, in use, substantially constant over the length of the wall's movement. Regardless of the displaced distance, therefore, always the same pressure will act on the wall and thus on the chamber if one disregards the counter-force of the spring which becomes more intensively compressed as the displacement increases. Since, however, the spring is relatively weak in relation to the force acting on the side of the wall remote from the chamber, the change in the counterforce of the spring may be disregarded.

With particular advantage, the side of the wall remote from the chamber communicates, in use, with the pressure on the supply side of the main valve. Thus, the supply pressure of the source, for example, of the water mains from the waterworks, acts on the chamber without establishing communication between the source and the conduit system that is being monitored, that is, without enabling fluid to enter the conduit system by by-passing the main valve. Moreover, no auxiliary energy source is required. Instead, an available pressure is made use of. The pressure in the conduit system being monitored can become no higher than the supply pressure from the source and that avoids excessive stressing of the monitored conduit system during monitoring.

In a preferred embodiment, a sensor is arranged to transmit a signal to the control means when the volume of the chamber has reached the second, smaller, value. That end position is, for example, required for the time measurement.

It is also preferred that the control means is arranged to open the main valve in response to the said signal. When the chamber volume has reached its smaller value, a pressure drop must have occurred in the conduit sytem. That pressure drop may be caused by usage or by a leak. For usage, the main valve must open so that the user can withdraw fluid from the conduit system. In the case of a leak, monitoring has to take place.

For monitoring a major leak, the time monitoring means is arranged to cause the main valve to be closed a predetermined time after the opening of the main valve. Since the leakage monitoring system is unable to differentiate between usage and a major leak, that measure ensures that only a limited maximum amount of fluid can escape from the conduit system.

Appropriate provision can be made so that a user who wishes to draw-off more fluid can give prior indication of that to the control means or so that he or she can interrupt the usage momentarily to signal to the control means that there is no major leak.

In a further preferred embodiment, the control means includes integrator means to integrate the test volumes of test fluid fed into the conduit system from the chamber. That enables a value to be available at all times that indicates the amount of leakage flow that has escaped up to that time.

It is also advantageous if the control means is arranged to lock the main valve in the closed position if the integrator detects a total volume of introduced test fluid which is above a predetermined value and/or if the volume flowrate of test fluid exceeds a predetermined value. When the volume flowrate exceeds a predetermined value, there will, as previously explained, be a fear of extensive damage even in the case of a minor leak. Another criterion which could also be combined with the first criterion is the fact that a certain total amount of leakage fluid has escaped. That amount can be chosen to suit the circumstances. Upon exceeding this predetermined leakage amount, however, the main valve should be closed to avoid extensive damage.

A method and apparatus, in accordance with the invention, for monitoring for leaks a conduit for an incompressible fluid will now be described, by way of example only, with reference to the single figure of the accompanying drawing which is a diagrammatic representation of the apparatus.

Referring to the accompanying drawing, a conduit system 8, for example, for mains water in a residential building, is fed by way of a main valve 1 from a source 7, for example, the water mains from a waterworks. THe main valve 1 is remotely controlled by an actuating apparatus 5 which is, in turn, operated by a control means 6. When the main valve 1 is closed, no water can reach the conduit system 8 from the source 7. The actual leakage monitoring equipment is arranged in parallel with the main valve 1. The leakage monitoring equipment consists of a cylinder 2 which is divided by a movable wall 4 into a pressure chamber 11 and another chamber 12. The pressure chamber 11 communicates with the supply side of the main valve 1. The chamber 12 communicates with the discharge side of the main valve 1, that is, with the conduit system 8. The wall 4 seals the chamber 12 from the pressure chamber 11.

The wall 4 is movable in the cylinder 2 so that the volume of the chamber 12 is changeable between a larger value when the wall 4 abuts the left-hand (as seen in the drawing) end of the cylinder 2 and a smaller value when the wall 4 abuts the right-hand end of the cylinder 2. The wall is pressed towards the left-hand end of the cylinder 2 by the force of a spring 10.

It will now be assumed that the main valve 1 is open without there being any water drawn-off from the conduit system through a tap 9. No water therefore flows through the main valve 1 and there will be no drop in pressure with respect to the mains pressure. The pressure P_1 on the supply side of the main valve, which is equal to the pressure of the source 7, is thus equal to the pressure P_2 on the discharge side of the main valve, that is, equal to the pressure in the conduit system 8. The pressure P_1 also obtains in the pressure chamber 11, whilst the pressure P_2 obtains in the chamber 12. Accordingly, the same pressure acts on both sides of the wall 4. Since, however, the wall 4 is additionally subjected to the force of the spring 10 on the side facing the chamber 12, the wall 4 will be displaced towards the left-hand end of the cylinder 2. At the right-hand end of the cylinder 2, there is a sensor 14 which is activated by a sensor stimulator 13 in the wall 4 when the wall is at its right-hand end position, that is, when the chamber 12 has assumed its smallest volume. When the wall 4 is pushed towards the left under the force spring 10, this positional change is detected by the sensor and signalled to the control means 6. A timing device now operates in the control means 6 and, after a predetermined time, signals the valve actuator 5 to close the valve. If no fluid is being withdrawn from the conduit system 8, the pressure will there remain constant, that is, the wall will remain in its left-hand end position.

If, however, a minor leak occurs, fluid will trickle out of the conduit system 8 to the outside surroundings, thereby gradually reducing the pressure P_2 in the conduit system. Since the wall 4 is subjected to the pressure P_1 of the source, which pressure obtains in the pressure chamber 11, the wall will shift to the right, whereby the test volume of fluid located in the chamber 12 is passed back into the conduit system. After a certain time, which is measured by the timing device 16, the wall 4 will reach its right-hand end position, which is detected by the sensor 14 which may, for example, be in the form of a reed relay. Since the test volume is known, the test volume and the time required by the test volume to flow into the conduit system 8 will enable one to calculate the volumetric flowrate, that is, the volume per unit time, that has escaped from the conduit system 8 through the point of leakage. Since the test volume enters the conduit system 8 without raising of the pressure, no higher pressure loads will occur in the conduit system 8 than if the main valve 1 were to open and allow the pressure from the source 7 to pass directly into the conduit system 8.

When the sensor 14 has signalled the fact that the wall 4 is in its right-hand end position, the control means 6 gives a signal to the valve actuator 5 for the main valve 1 to open again. The wall 4 is now displaced to its left-hand end position again in the manner described above and the testing cycle will start afresh.

The control means 6 comprises an integrator 15 which adds up the number of strokes made by the wall 4 and so, as the test volume is known, can provide an indication as to how much fluid has escaped altogether through the leak.

Since the test volume is over and over again introduced into the conduit system, it is possible to obtain a continuing indication revealing the current leakage volumetric flowrate. In addition, there is provided an indication of the quantity of leakage that has already taken place, so that, with the help of criteria based on these two leakage loss indications, indicator means can be actuated and relied upon as correct and/or the main valve 1 can be closed. For example, indicator means may be actuated when the leakage volume flowrate exceeds a first predetermined value, for example, 1 litre per hour. When the leakage volume exceeds the first predetermined volume and the escaped leakage volume exceeds a predetermined first value, for example, 60 litres, an indication can be given similarly and the integrator 15 reset to zero again. Naturally, a limit can be placed on the number of times the integrator can be reset to zero so as to prevent an excessively large amount of leakage fluid to escape through the leak. For example, one can ensure that on the third occasion the integrator 15 is not reset to zero but the main valve 1 is locked in the closed condition.

If the leakage volume flowrate is larger than a predetermined second value, for example, 3 litres per hour, the integrator is not reset to zero on reaching the predetermined first leakage volume but merely indicator means is actuated. Integration, that is, adding up of the individual test-volumes, is continued. If the integrator 5 finds that the quantity of leakage fluid that has escaped is larger than a predetermined second test volume, for example, 180 litres, the control means 6 similarly locks the main valve 1 in the closed position. In addition, the main valve can likewise be locked in the closed position when the leakage volume flowrate exceeds a predetermined second value. Preferably, however, the criterion for closing the main valve 1 will be made dependent on the previously escaped leakage volume, that is, the quantity of leakage fluid that has escaped.

The individual values for the leakage volume flowrates can, as mentioned, be, for example, 1 litre per hour for the first value and 3 litres per hour for the second value. Below a value of 1 litre per hour, the conduit system is considered to be leakfree. Above 3 litres per hour, one defines the leak as a large minor leak for which only a certain amount of fluid is to be permitted to pass before the main valve 1 is closed.

If a user wishes to withdraw water at the draw-off point 9 he or she may, for example, turn on a water tap (9), whereby the pressure P_2 will suddenly drop in the conduit system. The wall 4 is then very rapidly pushed to the right-hand end wall of the cylinder 1 under the pressure P1, whereupon the main valve 1 is opened. Water can now flow into the conduit system 8 from the source 7. The same events will take place if there is a major leak, for example, if a pipe breaks or there is a burst in the supply hose for a washing machine or a dishwasher. To prevent too much water from escaping in such a case, the timing device 16 closes the main valve 1 again a predetermined time after the pressure drop. This time is, for example, sufficient to allow a bath to be filled or for a user to have a generous shower, for example, the time may be fifteen minutes. Of course, there are also cases in which the user will want to draw-off water throughout a longer period, for example, to wash his or her car or to water the garden. In that case, he or she can signal that fact to the control means 6, for example, by actuating a switch to which the apparatus responds by fixing the maximum draw-off time for next usage to, say, two hours. For all subsequent user activities, however, the original time of, say, fifteen minutes will apply. Another possibility is for the timer device 16 to cause a sound or light signal to be emitted just before the expiry of the predetermined period, whereupon the user can close the draw-off point 9 momentarily. The pressure P_2 will thereupon rise to move the wall to the left again. At the instant when the control means 6 detects that the wall has left its right-hand end position, that is, the volume of the chamber 12 has increased again, the maximum draw-off time can start afresh. Such a pressure rise would be most unlikely in the case of a major leak. One therefore ensures that damage caused by a major leak will likewise be reliably kept relatively small.

CLAIMS:

1. A method of monitoring for leaks a conduit system for an incompressible fluid, in which test fluid is introduced into the conduit system during a test period when no fluid is being withdrawn from the conduit system and the conduit system is closed off on the supply side by a main valve, wherein a leak is detected by the introduction, without the entry of test fluid from the supply side of the main valve, of a predetermined test volume of test fluid under pressure and monitoring of the time required for the test volume to flow into the conduit system.

2. A method as claimed in claim 1, wherein the pressure under which the test fluid is introduced into the conduit system is of the same order of magnitude as the fluid pressure on the supply side of the valve.

3. A method as claimed in claim 2, wherein the pressure under which the test fluid is introduced into the conduit system is approximately the same as the fluid pressure on the supply side of the valve.

4. A method as claimed in claim 1, claim 2, or claim 3 wherein the test fluid is drawn from the conduit system before the test period.

5. A method as claimed in any preceding claim, wherein the test volume is less than 0.5 litres.

6. A method as claimed in any preceding claim, wherein after the completion of introduction of a test

volume of test fluid, a further test volume of test fluid is again drawn from the conduit system and retained available for introduction into the conduit system for leakage monitoring at a later time.

7. A method as claimed in claim 6, including determining the total volume of test fluid introduced by adding individually introduced volumes.

8. A method as claimed in claim 6 or claim 7, including making a continual determination of the leakage volumetric flowrate.

9. A method as claimed in claim 7 or claim 8, including producing an alarm signal when the total volume of test fluid introduced exceeds a predetermined first value and/or the leakage volumetric flowrate lies between a predetermined first and a predetermined second value.

10. A method as claimed in any one of claims 7 to 9, wherein the supply of fluid to the conduit system is interrupted completely if the total volume of test fluid introduced exceeds a predetermined second value.

11. A method as claimed in any one of claims 8 to 10, wherein the monitored total value of test fluid introduced is reset to zero if the leakage volumetric flowrate is reduced by a predetermined amount.

12. A method of monitoring for leaks a conduit system for an incompressible fluid, the method being substantially as herein described with reference to, and as illustrated by, the single figure of the

accompanying drawing.

13. Apparatus for monitoring for leaks a conduit system for incompressible fluid, the apparatus comprising a main valve for connection on the supply side of the conduit system, and control means for controlling the operation of the main valve, wherein a chamber, communicating, in use, only with the conduit system is provided for introducing a predetermined test volume of test fluid, the chamber having a volume capacity alterable between a predetermined first, larger, value and a predetermined second, smaller, value, and time monitoring means are provided for measuring the time taken for the chamber to reduce from the first volume to the second volume.

14. Apparatus as claimed in claim 12, wherein the chamber has one side closed by a movable wall.

15. Apparatus as claimed in claim 14, wherein the wall is movable against the force of a spring in the direction of movement leading to the smaller value of volume.

16. Apparatus as claimed in claim 14 or claim 15, wherein the movable wall is subjected on the side remote from the chamber to a force which is, in use, substantially constant over the length of the wall's movement.

17. Apparatus as claimed in claim 16, wherein the side of the wall remote from the chamber communicates, in use, with the pressure on the supply

side of the main valve.

18. Apparatus as claimed in any one of claims 13 to 17, wherein a sensor is arranged to transmit a signal to the control means when the volume of the chamber has reached the second, smaller, value.

19. Apparatus as claimed in claim 18, wherein the control means is arranged to open the main valve in response to the said signal.

20. Apparatus as claimed in any one of claims 13 to 19, wherein the time monitoring means is arranged to cause the main valve to be closed a predetermined time after the opening of the main valve.

21. Apparatus as claimed in any one of claims 13 to 20, wherein the control means includes integrator means to integrate the test volumes of test fluid fed into the conduit system from the chamber.

22. Apparatus as claimed in claim 21, wherein the control means is arranged to lock the main valve in the closed position if the integrator detects a total volume of introduced test fluid which is above a predetermined value and/or if the volume flowrate of test fluid exceeds a predetermined value.

23. Apparatus for monitoring for leaks a conduit system for incompressible fluid, the apparatus being substantially as herein described with reference to, and as illustrated by, the single figure of the accompanying drawing.

24. Apparatus as claimed in any one of claims

13 to 23 when used in a method as claimed in any one of claims 1 to 12.

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