An arrangement for preventing tap-water damage in building structures caused by leakage of water from a pressurized water system (16, 20). The arrangement includes a fitting which comprises a closure valve (12) and a pressure sensor (13), which are connected to the incoming pressurized water conduit (11), and a control device (14) in the form of an electronic unit which is placed in a convenient location in the building. In the case of normal water withdrawals from the various tap points (16) of the system, the control device will open the valve from its closed position, but in the event of a leak will issue a warning thereof and/or or lock the valve in its closed position. The electronic unit is constructed to register different pressures, pressure differences and time periods together with the course taken by certain events, in a manner to instigate the issue of a warning signal or locking of the valve in its closed position when the parameters registered do not fall within the programmed values of conceivable normal withdrawals of water from the system. The program and the parameters are adapted particularly to the pressure characteristic applicable to the water supply system concerned. Particular account is paid to whether the system contains air enclosures or not. The electronic unit is constructed to open the valve (12) when a given pressure difference is measured relative to a comparison pressure calculated suitably on the conduit pressure of the system.
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Device to prevent from water damages in buildings

The present invention relates to an arrangement for preventing tap water damage to building structures as a result of the leakage of water between one or more tapping-off points and an automatically controlled stop valve incorporated in a supply conduit for water under pressure, this conduit also incorporating a control device and a pressure sensor located downstream of the stop valve. The control device is constructed to effect opening of the valve from a normally closed position, when water is tapped from respective tapping-off points under normal water-consuming conditions, and to initiate a warning and/or to lock the valve in a closed valve position in the event of a leakage of water from the system.

Water leaks in the conduit system of buildings have become progressively more problematic in recent times, inter alia because of an increase in the length of piping or like conduits required and in the number of tapping points installed, and also because the building materials now used are more sensitive to water and moisture than was previously the case. The comprehensive repairs which are often necessitated by water damage incur significant inconvenience to those living in the water-damaged building or to businesses conducted therein, in addition to the heavy costs also involved. Several solutions have been proposed for the purpose of reducing or preventing totally structural damage resulting from faulty pressurized water systems, these solutions taking the form of arrangements which are effective in measuring the pressure and flow rate of the water in the system and in causing a main valve to be closed when a leak would seem to have occurred. However, those arrangements which have hitherto been proposed or put into practice are much too primitive to function troublefree in dwellings and office buildings,
etc. These known arrangements will often turn off the main valve even when no leak has occurred. A more serious drawback, however, is that the known arrangements are not adequate enough to issue a leak warning in all of the complicated pressure and flow situations that are likely to occur in present day consumer tap-water systems, and cannot therefore be totally relied upon.

Consequently, it is an object of this invention to provide an arrangement which will prevent such water damage to buildings and which is not encumbered with the drawbacks of known prior art arrangements of this kind. Thus, the inventive arrangement will be capable of shutting off the water supply or of warning that a leak has occurred, irrespective of the size of the leak or its location in the system, and which will not be prone to give a false alarm or to turn-off the water supply unnecessarily and thereby disturb those concerned without real cause. Furthermore, the inventive arrangement shall not restrict or impede the supply of water. These and other objects of the invention and advantages afforded thereby will be apparent from the following description and are achieved with an inventive arrangement having the characteristic features set in the following claims.

The present invention is based on the realization that variations in pressures and flow rates in conventional tap water systems of standard houses, offices blocks, childrens playshools, and like buildings are more complicated than would be expected. For instance, the prior art leak monitors have not taken into account the fact that such water supply systems will often contain air. The inclusion of air in water pipes may result in a leak in the system being mistakenly discerned by the monitor as a plurality of short withdrawals of water from the system and thus exclude the issue of an alarm. The effect of air enclosed
or trapped in the system is most often related to the hot water boiler or corresponding water heater of the system, which boiler will always contain a certain amount of air influential in the hot water system. It is also quite common for the check valve, or non-return valve, incorporated in the pipe connection to the cold water system to malfunction, so that air will also enter the cold water system, and therewith the whole conduit or pipe network. A serious situation can arise should hot water be forced into the closed cold water system, for instance at the moment when a shower is being taken.

According to the present invention, a pressure sensor is arranged to sense and measure the water pressure prevailing downstream of the stop valve in a closed conduit system. This pressure is sensed and measured continuously, so as to open or close the valve in response to the fulfillment of certain time and pressure conditions. These pressure conditions are adapted successively to the pressure conditions prevailing within the conduit system, so that the command for, e.g., opening the valve can be given in response to very small measured differences in pressure. This will avoid the aforesaid danger of being scalded as a result of hot water entering the cold water system, and also other drawbacks. However, the control conditions or parameters under which the arrangement will operate cannot be incorporated in one and the same control circuit, since different systems have widely varying characteristics, e.g. such systems as those which contain air and those which do not. Accordingly, in order to provide an arrangement which can be used generally and which can be readily adjusted, the control device is provided with at least two master programs, one for each main type of system. According to a wider aspect of the invention, the control device is constructed to warn the user if the wrong main program has been selected and also always to
perform its main function, i.e. of closing the valve in the event of a serious leak, irrespective of whether the wrong program has been selected or not. The term "serious leak" used here and in the following is meant to include the escape of water from the system through a tap which has been left open inadvertently.

The invention will now be described in more detail with reference to an exemplifying embodiment thereof illustrated in the accompanying drawings, in which

Figure 1 illustrates schematically a water supply system which incorporates an arrangement according to the invention;

Figure 2 is a simplified block schematic of the control program applied for opening and closing the stop valve;

Figure 3 is a diagram illustrating the variation of pressure with time when sensing pressure with the aid of the pressure sensor;

Figure 4 is a graphic illustration of the pressure variations which occur when water is withdrawn from a tapping-off point;

Figure 5 is a graphic illustration of the pressure variations which occur when all tapping-off points are taken as being closed; and

Figure 6 is a graphic illustration of the pressure variations which occur in the event of a leak or when water is withdrawn very slowly.

Fig. 1 illustrates schematically an arrangement according to the invention connected to an incoming pressurized water pipe 11. The arrangement includes a stop valve 12 which is fitted in the pipe 11 and which has the form of a solenoid valve which is normally closed. The inventive arrangement also includes a control device 14 which is operative in opening and closing the valve 12. The valve
12 will thus form an obstruction in the incoming pipe 12, such as to provide a closed tap-water system within the building. The system pressure is measured continuously by the sensor 13, which may have any appropriate form. The valve and the pressure sensor are each connected to the control device 14, which includes a programmable electronic unit which is effective in controlling the valve in a manner described more clearly hereinafter. Conventionally, the water conduit system will include a hot water boiler 15 and a plurality of tap points 16, of which only one is shown, and this in the form of a mixer tap. Cold water is delivered to the boiler 15 in a conventional manner, via a connecting pipe 17 and a non-return valve 18. Hot water is taken from the boiler through a hot water pipe 19 which is connected to the mixer valve 16 together with a cold water pipe 20.

The arrangement can be installed easily, even in existing buildings. Thus, the stop valve and the pressure sensor can be connected to the incoming supply pipe, e.g. immediately downstream of the water meter. In all other respects no mechanical work need be carried on the water conduit system, with the exception of providing access to a supply of electric current for operation of the electronic unit. The unit is placed in an easily reached location, e.g. on an outer door. The electronic unit has an instrument panel 22 for manual operation of the control system. Located on the outside of the panel 22 is a first switch 23, which enables the water supply to be shut-off, simply by moving the switch to its OFF-position. This will be done, for instance, when the premises are to be left unoccupied over a long period. Also located on the panel is a second switch 24 which enables the automatic control device to be disconnected and therewith shut down the system. This will be done, for instance, when water is drawn from the system over an unusually long period of
time, for instance when watering the garden or in some like instance. A button 25 is provided for resetting the electronic unit subsequent to an alarm being given. As beforementioned, the control system is intended to give an alarm or to close the stop valve, said valve being closed when pressure variations measured over various time periods do not coincide with programmed predetermined values. In order to provide a simple but still effective system, the system is not programmed for all situations under which water might conceivably be tapped from the system. Instead, the consumer himself is expected to set on the panel 22 the length of time over which water may be taken from the system before a leak alarm is given. This time period, which can be referred to as the "comfort period", is set by means of a rotary switch 26. This period can be set for any length of time between 5 and 20 minutes. The panel will also signal an alarm in the event of normal leaks, so-called serious leaks, and also small leaks, so-called drip-leaks. The alarm is given in the form of flashing lights from two lamps 27. In addition to warning that a leak has occurred, the arrangement can also be used to warn that the water supply system has remained unused for a long period of time, thereby acting as a monitor in old peoples homes and like places, for issuing an alarm which will indicate the possible sickness of the person or persons concerned. As mentioned in the introduction, the water supply systems of standard buildings can be divided into two categories, i.e. systems which are under the influence of enclosed air and those which are not. When the system to which the inventive arrangement is fitted is under the influence of air, the system will be characterized by a higher degree of inertia or sluggishness, and the electronics of the inventive arrangement must be constructed to take this into particular account. Since a very large proportion of water supply systems fall into this latter category and since it is not always pos-
sible to anticipate the type of system to which the arrangement will be fitted, the electronics are suitably designed so as to be readily adaptable to both of these main system categories. It shall be understood, however, that the arrangement may also be made adaptable to other systems and that other main types of program may be used. In the case of the illustrated embodiment, the program can be set with the aid of the rotary switch 26, which switch can be set to any one of three so-called A-positions for de-aerated or sluggish systems or to any one of three so-called H-positions for systems which are subjected to hydrophoric effects or some other spring effect.

The electronic unit control program is illustrated in the simplified functional diagram of Fig. 3. The program is started either by operating the switch 23 or by pressing the reset button 25 on the control panel 22. The monitoring facility is then indicated, which includes, inter alia, setting the counters to zero and testing the warning lights on the panel 22. The value of the pressure detected by the pressure sensor 13 is read into the logic memory and if this value lies within a reasonable pressure range, indicated diagrammatically at 29, the value is used to calculate a suitable comparison pressure, which is shown as the pressure control value 30 in the diagram. If the pressure measured in the conduits falls outside the given pressure range, e.g. 50-800 kPa, the program will instigate an immediate alarm indicative of the occurrence of a serious leak, as shown graphically at 31, whereupon the solenoid valve 12 is closed and the lamps 27 are ignited. This serves two purposes. Firstly, the water supply will be tapped-off immediately when the leak is very large, as in the case of a broken pipe, and secondly it is guaranteed that the arrangement will only be used in systems for which it has been adapted. The control pressure value 30 is not only calculated on the basis of the pressure last
measured, but also on the basis of a judicious balance between the latest pressure values read into the logic memory of the program. The electronics will then switch to a searching mode 32, in which the pressure prevailing in the system is measured while, at the same time, passing through a number of query frequencies. The first query 33 of the sequence inquires whether the switch 23 is on or off. The electronic logic will retain certain functions even when in the cut-off state 34, e.g. functions effective in the detection of small leaks, so-called drip leaks. Leaks of this nature can be assumed to have occurred when, e.g., the system pressure falls by more than 100 kPa over a period of less than 6 hours, such leaks being appropriately indicated by the lamps on the panel 22. If the electronic unit is switched on, a check 35 is again made to ascertain whether or not the pressure has remained within reasonable values, whereafter a check 36 is made as to whether the automatic control device is switched on or not. As beforementioned, the automatic control device can be disconnected temporarily, by pressing the button 24 on the control panel. A check 37 is also made to ascertain whether or not the time period for activating the safety alarm has expired. The aforesaid query sequence also includes function 38 which investigates whether the pressure has remained at a constant higher value or whether a given drop in pressure has been detected. Such a drop in pressure can have been occasioned by turning on a tap. If this pressure exceeds a given value, the solenoid valve 12 is opened so as to enable normal quantities of tap water to be drawn off. In the case of small drops in pressure, the program will return to its searching mode 32 and repeat the aforesaid query sequence.

The pressure differential at which the normally closed solenoid valve 12 is opened should be as small as possible, so as to avoid pressure variations in the system to
the best possible extent, and primarily to avoid hot water from flowing "backwards" within the system, e.g. as a result of leaky non-return valves 18, and from entering the cold water supply pipe 20. The pressure differentials should not be too small, however, since this would result in unnecessary working of the solenoid valve and the creation of disturbances. Furthermore, it would be difficult to measure and thus to indicate drip leaks if the system were to be made too sensitive to pressure differences. It has been found that suitable values in this respect are at least 50 kPa in the case of A-program, where substantially no air will be present in the water supply system, and at least 30 kPa in the case of the H-program, where said system will be subjected to the effect of air enclosed therein. When the valve is open in accordance with item 39 of the illustrated program, it is necessary to ascertain in the program whether or not the valve is open because of a leak or because water has been withdrawn from the system intentionally. Before a check is made, however, the program will first ascertain whether or not the main program coincides with reality, i.e. whether or not the control device has been wrongly set to an A-setting for a water supply system in which air is enclosed. This check is made simply by adding the number of times the valve has been opened, Pn, so as to check whether this number exceeds a given chosen value Pk item 40, before the commencement of the aforesaid comfort time. If this number Pn is found to exceed the value Pk, an alarm is given to the effect that a serious leak 31 has occurred. The periodic constant will preferably lie somewhere in the range of 20-40 valve-opening occasions, since such a large number of very brief withdrawals of water from the system is highly improbable in the case of standard water supply systems. When the comfort time period 37 commences in the control or check phase, the program will pass through a number of new conditions and will check whether or not the alarm is
activated, as in the previous case, and also whether or not the system pressure has remained within reasonable limits, item 41, and whether or not the automatic control device is switched on or off. The program will then determine the possible occurrence of a drip leak, item 42, with the automatic control device switched on. The occurrence of a drip leak is established by measuring the time lapse between each zero setting, i.e. the time lapses between successive switching of the electronics to the search mode and the subsequent opening of the valve 12. An alarm to the effect that a drip leak has occurred is given when two or more such time lapses coincide with one another. The registration of such time periods may have an upper limit of one hour for instance. If no drip leak is established, a check 43 is made to ascertain whether or not withdrawal of water from the system still lies within the set comfort time. If this is so, the system pressure is measured and a new control pressure value is calculated or established in accordance with program item 44. The solenoid valve is then closed briefly, in order to ascertain whether or not the pressure falls off in the temporarily closed system, program item 45. If no drop in pressure is registered, it is assumed that water is no longer being taken from the system and the program will return to its search mode 32, after the comfort time 46 has been set to zero. In all other instances it is assumed that water is still being taken from the system, wherewith the valve 12 is re-opened, the time is counted down from the comfort period, and the periodic constant is set to zero, in accordance with program item 47. The check phase is then repeated. The pressure drop during said check period 45 shall be at most 30 kPa in both main programs, in order to achieve re-opening of the valve. The time period over which the pressure is measured should be longer in the H-program than in the A-program, preferably 7-20 seconds as opposed to 1-10 seconds. Consequently, a smaller drop in pressure is
required to open the valve in the check phase than in the case when the valve is opened for the first time, item 35. It will be ensure that the pressure difference will never be so large as to risk the backflow of hot water into the cold water pipe, but, at the same time the pressure differential required to open the valve for the first time may be sufficiently large to avoid the aforesaid drawbacks associated with excessively small pressure differences. The risk of being scalded when water is drawn from the system for the first time is also very slight, since water in the hot water pipe will have had time to cool, if the mixer tap 16 has remained turned off for a given shorter period of time.

When water continues to be taken from the system during the check phase, over a time period which exceeds the comfort time period, a so-called warning phase is initiated in accordance with program item 48, so that the user will be warned that the supply of water to the system will be cut off, if water is continued to be drawn from the system. This is effected in the aforesaid phase 48, by closing and opening the valve 20 in cycles of 10-20 seconds and by measuring the system pressure after the last time of closing the valve in said sequence, for the purpose of ascertaining whether the pressure prevailing is still beneath the control value, with a difference which is greater than the pressure difference which steered the program during the check period 45. If the pressure is not higher, an alarm is given to indicate the occurrence of a serious leak, otherwise the system will return to its search mode 32. The warning phase 48 can be utilized to restart the comfort period, e.g., when taking a shower, simply by switching off the shower briefly.

The described program ensures that the arrangement will always shut-off the water supply in situations represen-
tative of a serious leak in the system, irrespective of whether or not the user has switched the arrangement to the wrong main program. If the system to which the arrangement is fitted is an H-system and the arrangement is switched to an A-system, the serious leak warning facility will be rendered inactive if the periodic constant was omitted from the program. In this case, the drop in pressure would be too slow to be registered within the span of the check period 45 and the leak would be taken as a plurality of separate, brief withdrawals of water from the system, and would not therefore trigger an alarm or cause the system to be shut down. Each wrong setting will result in a multiple of unjustified or unexplainable interruptions in the water supply and therefore cause the user to check and alter the settings. The periodic constant can also be utilized to shut the solenoid valve, if the pressure continues to fall without the system being used normally. The detected drop in pressure will then coincide with the described condition of wrong program selection.

The modus operandi of the inventive arrangement will be described still further in the following, with the reference to pressure diagrams representing different water-withdrawal and water-leakage situations.

Fig. 3 illustrates the possible graphic appearance of the pressure drop sequence occurring during the check period 45. When the valve is closed at t1, either the pressure will fall rapidly as a result of a large quantity of water being withdrawn from the system, curve A, or will fall slowly as a result of a drip leak, curve B. The broken curve C illustrates a suitable limit value at which the majority of withdrawals will be accepted as normal withdrawals and load the comfort time without the aforesaid sudden occurrence of hot-water shocks in the cold water conduit. When the system contains no air,
the pressure drop $\Delta P$ should therefore be chosen at a value beneath 30 kPa and the period within which this pressure drop takes place should be from 1 to 10 seconds. This time period can be increased to 7-20 seconds if the system is more sluggish as a result of air inclusion. Fig. 4 illustrates the event which takes place when a normal withdrawal is made from the system, by normal being meant here the quantity of water required to wash ones hands or to operate a dishwasher. As illustrated in Fig. 4, the valve 12 is initially closed and the pressure sensor 13 determines the pressure then prevailing in the closed conduit system. When a tap is opened, e.g. the mixer tap 16, at $t_1$, the system pressure will drop progressively until the first selected difference is reached at $t_2$. As beforementioned, this pressure difference is preferably at least 50 kPa in the case of the firstnamed program and at least 30 kPa in the case of the second program intended for air-containing systems. When the valve is subsequently opened, the system pressure will rise to the mains supply pressure, minus those flow losses experienced in the valve. The control program is now in its so-called check phase, wherewith a newly calculated pressure control value is taken at $t_3$ after about 20 seconds. The valve is then closed, $t_4$ and a check period 45 is initiated. In the illustrated case, the pressure falls beneath the established limit value, which is interpreted as indicating continuous withdrawal of water from the system, wherewith the valve is reopened at $t_5$. A new pressure is established or calculated at $t_6$ and a new check period is traversed between $t_7$ and $t_8$. When withdrawal of water from the system ceases at $t_9$, the system pressure will rise slightly due to a reduction in flow losses, wherewith the next pressure control value established at $t_{10}$ will be slightly higher. The pressure does not fall during the next following check period between $t_{11}$ and $t_{12}$, and consequently the comfort time is set at zero and the program returned to the search mode 32.
The state illustrated in Fig. 5 is instigated when the water supply system is at rest, i.e. the electronic unit is switched on but all of the tap points are closed. Because it is unusual for a water supply system to be completely free from leaks, in the form of leaking taps etc., the valve 12 will be opened at long intermediate intervals. Preferably, the program is compiled so as not to initiate a leak warning when the leak is so small as not to be harmful. The example illustrated in Fig. 5 shows the pressure curves of a water supply system which is subjected to such a drip leak sequence. At t1, the system pressure is determined in the aforesaid manner and the valve 12 is subsequently closed for a check period at t2. However, at the end of this check period, t3, no significant pressure difference has been established, wherewith the comfort time has been set to zero and the valve is kept closed. At t4, however, the pressure has fallen to such an extent that the logic 38 orders opening of the valve. The systems is therewith again pressurized and new check periods are initiated at t5 and t8. Re-opening of the valve also takes place at t7. The respective time spans between t3 and t4 and between t6 and t7 are measured and the resultant values are stored in drip leak logic 42. A drip leak alarm is given when two or more mutually similar time values are entered in sequence. Preferably, the drip leak logic is constructed to react when three time values are identical, and each time period is selected to be not longer than 1 hour. Such selection will obviate essentially the occurrence of a random drip leak warning and will also avoid warning of insignificant leaks.

As will be understood, the main purpose of the inventive arrangement to shut off the water supply and to issue an alarm in the event of heavy water leaks. An example of the events which take place in this instance is presented graphically in Fig. 6. Similar to the procedure illustra-
ted in Fig. 5, water is tapped from the system with a sub-
sequent drop in system pressure until the valve 12 opens,
whereafter a given number of check periods K1 to Kn are
undergone up to the expiry of the comfort time, at time
t1, e.g. after a time lapse of 10 minutes. The so-called
warning phase 48 now commences, in which the valve 12 is
first closed for a given period of time, e.g. from 10-20
seconds. This results in emptying of the conduit system
and the pressure will decrease until time t2 is reached,
at which time the valve is re-opened and the system is
again pressurized. This procedure is repeated for a fur-
ther period or periods, until the valve is again closed at
t3. If a tap responsible for the withdrawal of water from
the system is still open, or if said withdrawal is due to
a serious leak, the pressure will fall to zero at t4. A
last check measurement is carried out at t5, e.g. after 10'
seconds from t3, and if the measured pressure still repre-
sents a difference which is more than a given difference
from the calculated or established pressure control value,
an alarm is given to indicate the occurrence of a serious
leak and the valve 12 is closed and can only be re-opened
on manually re-setting the system.

It will be understood that the invention is not limited to
the illustrated embodiment and that modifications and
changes can be made within the scope of the following
claims.
CLAIMS

1. An arrangement for preventing tap-water damage to building structures as a result of the leakage of water between one or more tap points (16) and an automatically controlled stop valve (12) incorporated in an incoming pressurized water conduit (11), the arrangement including a control device (14) and a pressure sensor (13) incorporated in the water conduit downstream of the stop valve, the control device in the case of normal withdrawals of water from various tap points in the building being intended to open the valve from a normally closed position but to lock the valve in a closed position in the event of a leakage and/or to warn of the occurrence of such leakage, characterized in that the control device includes a programmable electronic unit which is operative in registering different pressures, pressure differences and times and the number of given events such as to engender said warning signal or said locking of the valve (12) in its closed position when the parameters registered do not fall within programmed values for conceivable, normal withdrawals of water from the water supply system concerned; and in that the electronic unit is constructed to open the valve when a given pressure difference (38) is measured in relation to a suitable comparison pressure (30, 44) calculated on the basis of the conduit pressure.

2. An arrangement according to Claim 1, characterized in that the program and parameters of the electronic unit are adapted to apply irrespective of whether the water supply system contains an enclosed quantity of air or not.

3. An arrangement according to Claim 2 or 3, characterized in that the electronic unit can be switched between at least two mutually different main programs, a first pro-
gram having parameters which are adapted to a water supply system in which a given quantity of air is enclosed, and a second program intended for a system which contains substantially no air.

4. An arrangement according to any of the preceding claims, characterized in that the electronic unit is constructed to close the valve in one or more brief check periods (45) during a given normal withdrawal of water from the system; and in that said given pressure difference for opening the valve (12) is intended to take a second, lower value during these check periods.

5. An arrangement according to Claim 4, characterized in that the electronic unit is constructed to register the conduit pressure prior to each check period (45) and then to use two or more such registrations for the purpose of establishing said comparison pressure (44).

6. An arrangement according to Claim 4 or 5, characterized in that the electronic unit is constructed to register the number of times the valve (12) is opened and to set to zero said registration and to close the valve if the second, lower pressure difference is not reached, but in other respects and after a given number of valve openings to lock said valve in its closed position and/or to issue an alarm signal.

7. An arrangement according to Claim 6, characterized in that the electronic unit is constructed to register the time phase (47) for the check periods (45) so as to lock the valve in its closed position and/or to issue a warning signal when the number of times which the valve (12) is opened exceeds a given number, suitably 20-40, without a time phase being registered.
8. An arrangement according to any of the preceding claims, characterized in that the electronic unit is constructed (29, 35, 41) to lock the valve (12) in its closed position and/or to issue an alarm signal when the pressure detected lies outside the range 50-800 kPa.

9. An arrangement according to any of Claims 4-8, characterized in that the first measured pressure difference (38) for opening the valve (12) shall be at least 50 kPa in the first main program and at least 30 kPa in the second main program; in that following, second pressure differences measured during the check periods (45) shall be at most 30 kPa in both programs; and in that said check periods shall be 1-10 seconds in the first main program and 7-20 seconds in the second main program.

10. An arrangement according to any of Claims 6-9, characterized in that the electronic unit is constructed to measure time periods between each zero setting (46) and the next opening (39) of the valve, so as to effect the issue of a warning signal and/or locking of the valve in its closed position when two or more sequential time values essentially coincide within a given longer time period.
INTERNATIONAL SEARCH REPORT

International Application No. PCT/SE88/00373

I. CLASSIFICATION OF SUBJECT MATTER (if several classification symbols apply, indicate all) 4

According to International Patent Classification (IPC) or to both National Classification and IPC 4

F 17 D 5/02

II. FIELDS SEARCHED

Minimum Documentation Searched 7

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<td>F 17 D 5/00, 5/02, 5/06; G 01 M 3/26, 3/28</td>
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<td>US Cl</td>
<td>137:456, 487.5, 495, 624.11, 624.12</td>
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Documentation Searched other than Minimum Documentation to the Extent that such Documents are Included in the Fields Searched 4

SE, NO, DK, FI classes as above

III. DOCUMENTS CONSIDERED TO BE RELEVANT 6

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<td>Y</td>
<td>DE, B2, 2 500 262 (SOCIETE NATIONALE DES GAZ DU SUD-OUEST) 10 July 1975 See page 4, 2nd and 3rd paragraph &amp; BE, 823862 NL, 7500182 FR, 2257080 US, 3962905 GB, 1482304 CA, 1041192</td>
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<td>A</td>
<td>GB, A, 2 034 392 (KEITH BAKER) 4 June 1980 See whole document</td>
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* Special categories of cited documents: 10

**A** document defining the general state of the art which is not considered to be of particular relevance

**E** earlier document but published on or after the international filing date

**J** document which may throw doubts on priority claim(s) or which is cited to establish the publication date of another citation or other special reason (as specified)

**O** document referring to an oral disclosure, use, exhibition or other means

**P** document published prior to the international filing date but later than the priority date claimed

**T** later document published after the international filing date or priority date and not in conflict with the application but cited to understand the principle or theory underlying the invention

**X** document of particular relevance; the claimed invention cannot be considered novel or cannot be considered to involve an inventive step

**Y** document of particular relevance; the claimed invention cannot be considered to involve an inventive step when the document is combined with one or more other such documents, such combination being obvious to a person skilled in the art.

**A** document member of the same patent family

IV. CERTIFICATION

Date of the Actual Completion of the International Search 1988-10-18

Date of Mailing of this International Search Report 1988-10-21

International Searching Authority Swedish Patent Office

Signature of Authorized Officer Inger Löfving

Form PCT/ISA/210 (second sheet) (January 1985)
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