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GB 2320351 A GB 2310068 A EP 0896212 A2
EP 0066716 A1 WO 95/13497 A1 US 5139044 A

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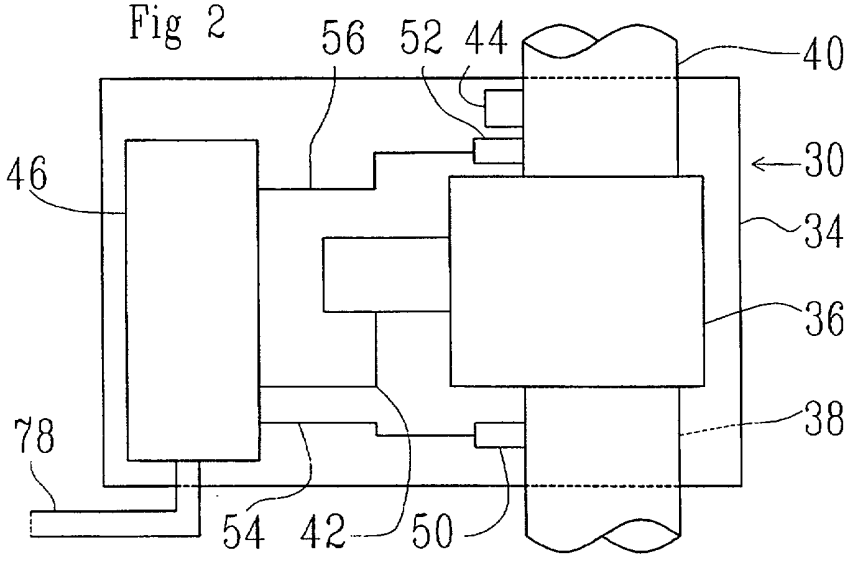
Online databases: EPODOC, JAPIO, WPI

(54) Abstract Title
Controlling a water supply to minimise leakages

(57) A flow interrupting device, such as a solenoid-operated valve 36 operative to connect a mains supply at 38 to a water supply installation at 40 or isolate the installation from the mains. Controller 46 receives a signal from a flow sensor and closes the valve 36 under conditions where there has been a continuous flow for a set period of time and preferably when the flowrate is above a predetermined level for a set period. The valve may also be closed when there has been minimal or no flow for an extended period of time, eg when a premises has been unoccupied for that period. A leak detection mode using pressure transducers 50, 52 can also be initiated at off-peak times to detect a pressure drop in the installation over a period of time. Visual/audible alarms may be also generated when leakages real or potential are detected.

Fig 2



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At least one drawing originally filed was informal and the print reproduced here is taken from a later filed formal copy.

The claims were filed later than the filing date but within the period prescribed by Rule 25(1) of the Patents Rules 1995.

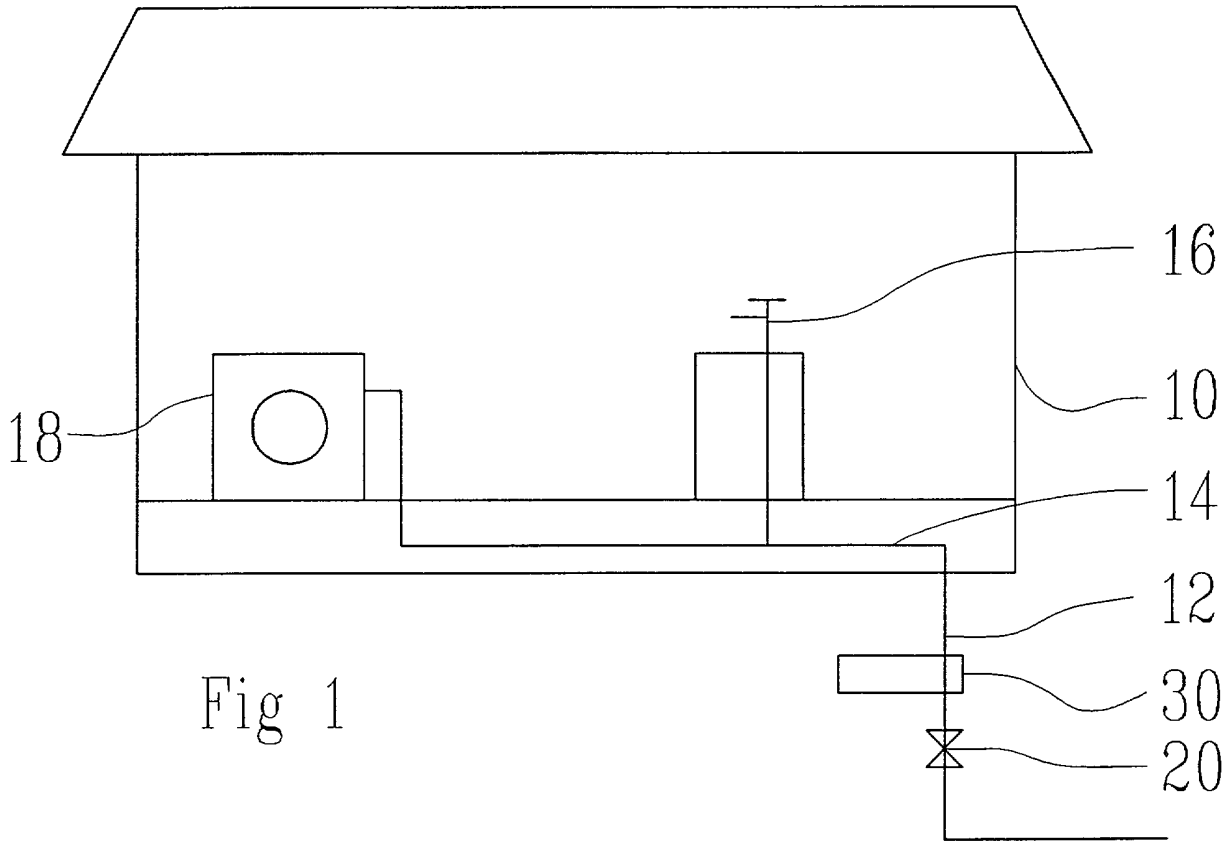
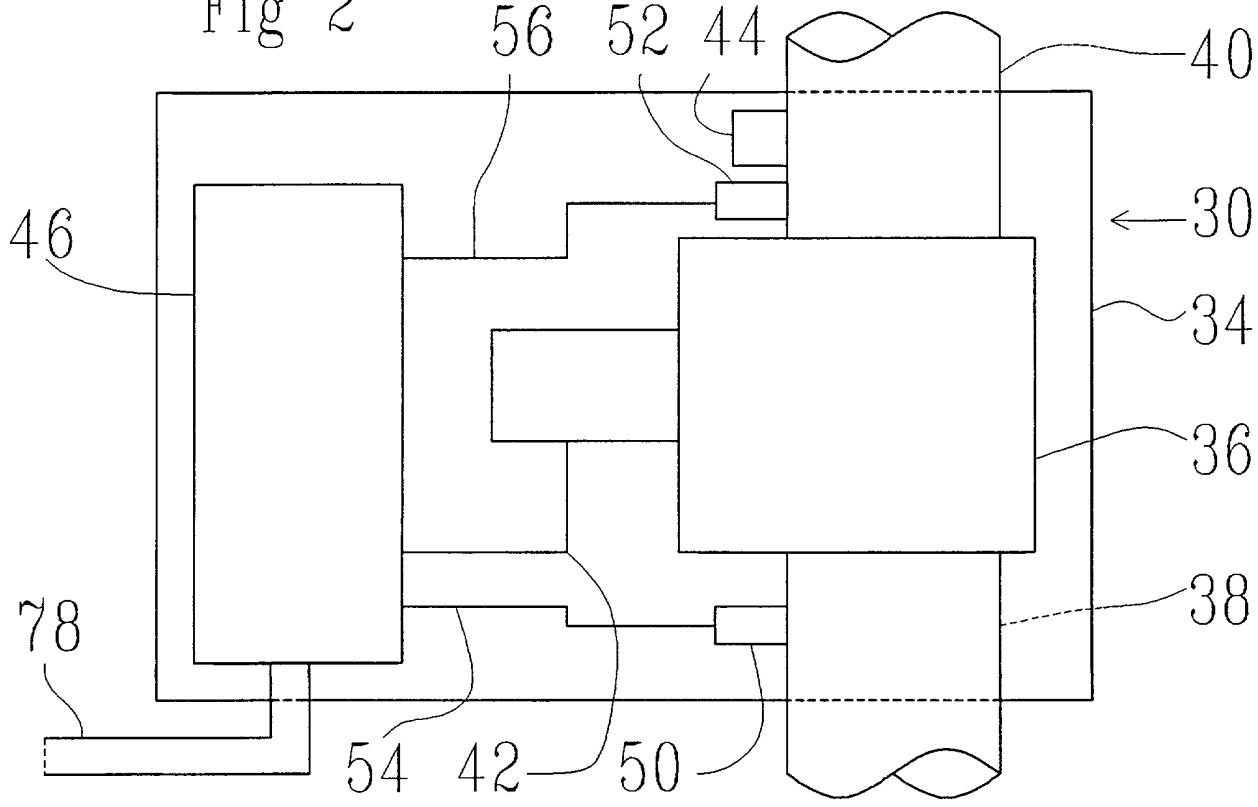


Fig 1

Fig 2



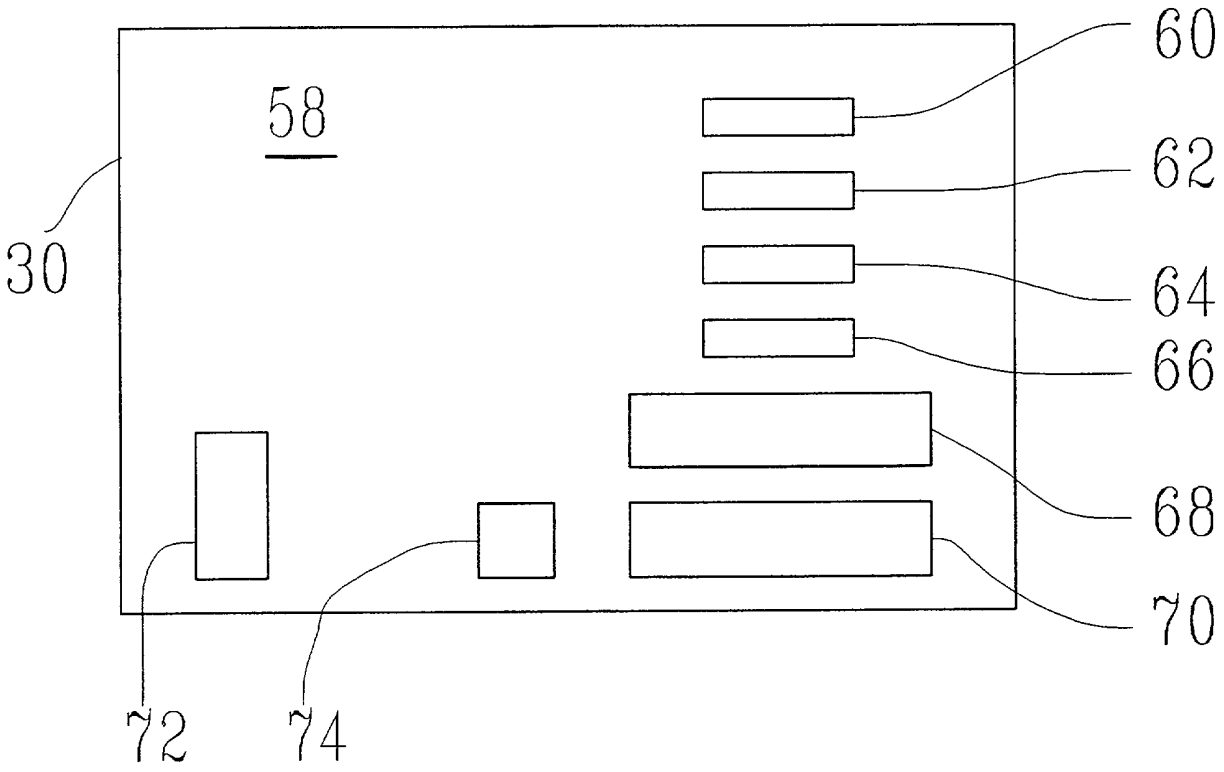


Fig 3

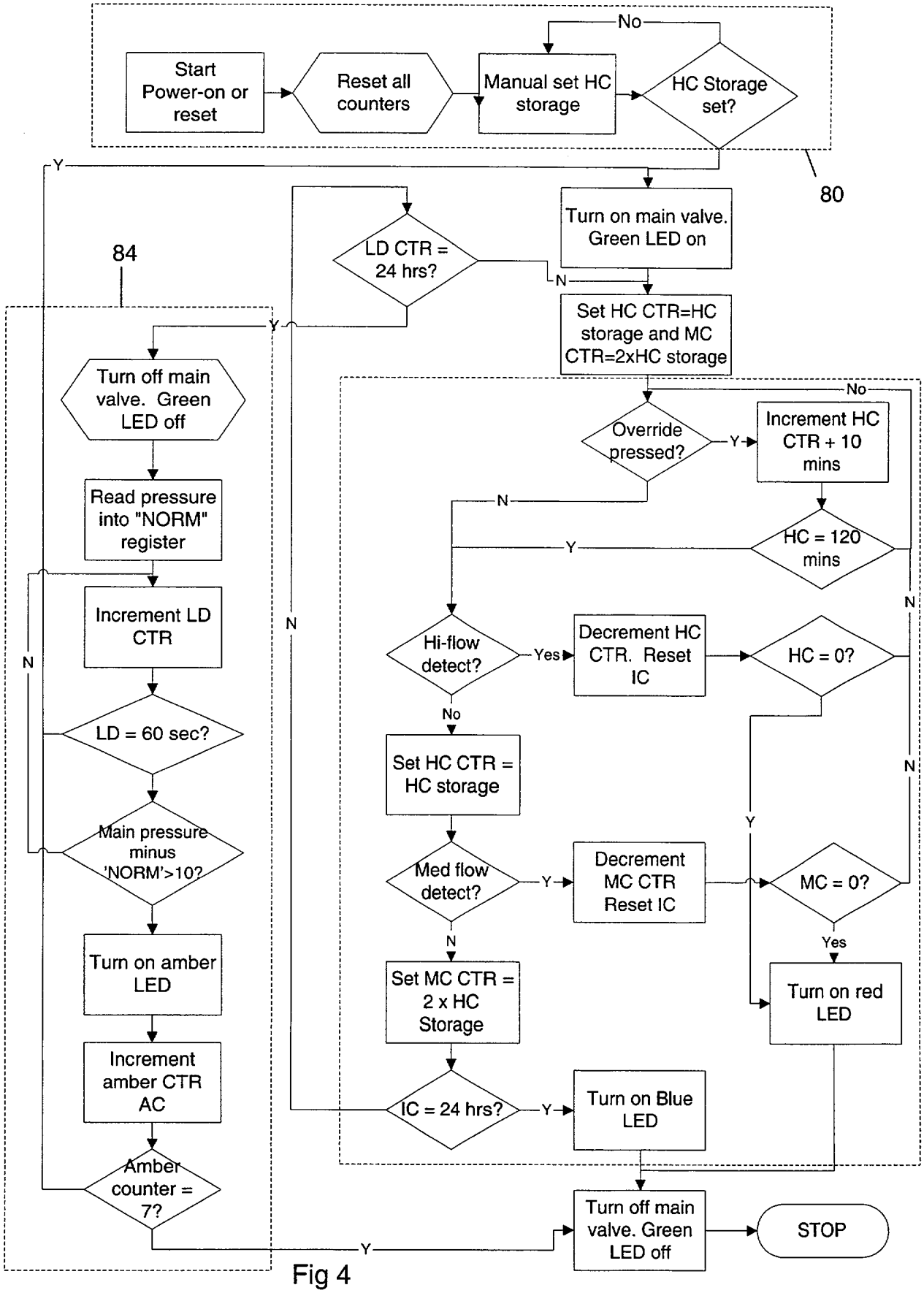

Start Power-on or reset
Reset all counters
Manual set HC storage
HC Storage set?
No
Y
80
84
Turn on main valve. Green LED on
LD CTR = 24 hrs?
N
Y
Set HC CTR=HC storage and MC CTR=2xHC storage
Turn off main valve. Green LED off
Read pressure into "NORM" register
Increment LD CTR
LD = 60 sec?
Main pressure minus 'NORM'>10?
Turn on amber LED
Increment amber CTR AC
Amber counter = 7?
Override pressed?
Increment HC CTR + 10 mins
HC = 120 mins
Hi-flow detect?
Yes
Decrement HC CTR. Reset IC
HC = 0?
Set HC CTR = HC storage
Med flow detect?
Decrement MC CTR Reset IC
MC = 0?
Set MC CTR = 2 x HC Storage
IC = 24 hrs?
Turn on Blue LED
Turn on red LED
Turn off main valve. Green LED off
STOP

Fig 4

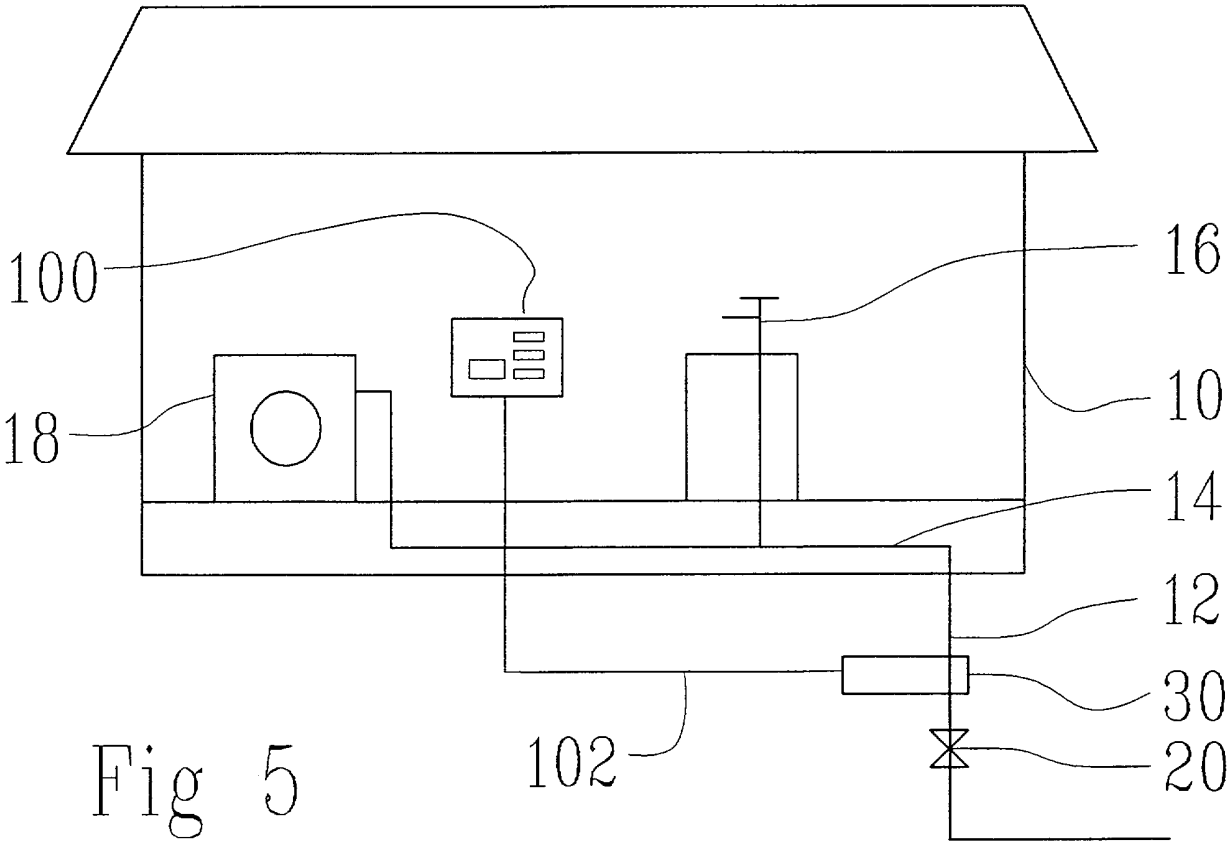


Fig 5

Controlling a water supply

The present invention relates to apparatus and methods for controlling a water supply. In particular, it relates to controlling a water supply a to premises such as residential or commercial premises.

Typically, commercial and domestic premises have a water supply installation that includes a number of water outlets all fed through a network of pipes from a pressurised mains supply. Each outlet has some form of control, for example, a manually operated tap or stopcock, or an automatic valve such as may be found in an appliance for example, a washing machine.

While the premises are in routine occupation, it is normal that the entire water supply system remains under pressure continuously. This means that all of the outlets and all of the pipes must remain entirely watertight, otherwise a leak will occur.

Many of the leaks that occur in a water supply installation are of a relatively minor nature. For example, an improperly closed tap or a valve in which a washer is beginning to fail may cause minor leaks. Not all such leaks to cause damage to the premises, but they have the potential to do so, and all are wasteful of water. Water can also be wasted through simple inattention, such as a person forgetting to turn off a tap. On the other hand, more major leaks can occur. These may be caused, for example, by sudden failure of a pipe due to icing. If remedial action is not taken quickly after such a leak occurs, there is a likelihood that damage will occur to the premises. As a precaution against extensive water leakage, when leaving premises unoccupied, it is good practice to isolate the water supply installation from the mains supply. However, in a conventional installation this is often not done, because of the inconvenience of accessing and operating a main stopcock.

It is an aim of the present invention to provide methods and apparatus for controlling a water supply that reduces the risk of water are being wasted or damage being caused.

From a first aspect, the invention provides apparatus for use in a water supply installation, the apparatus comprising a flow interrupting device operative to connect to the installation to or isolate the installation from mains water, a controller for operating the flow interrupting device, and a flow sensor for monitoring the flow of water into the installation.

Such apparatus has the ability to isolate the installation from mains water when conditions suggest such action to be appropriate.

The apparatus, for example, may operate to isolate the installation from mains water in the event that water flows into the installation for a time period greater than a threshold time. More preferably, the apparatus may operate to isolate the installation from mains water in the event that water flows into the installation at greater than a threshold rate for a time period greater than a threshold time.

The apparatus may further comprise a pressure detecting device operative to monitor pressure of water within the installation.

The apparatus may operate so as to cause the flow interrupting device to isolate the installation from mains water in the event that the flow sensor detects no flow or minimal flow for a time period greater than a threshold time. The effect of this is to isolate the installation in the event of an extended period of non-use, for example, during a period of non-occupation of a building.

From another aspect, the invention provides a method of operating a water supply installation wherein, in a leak detection mode, the installation is isolated from a supply of mains water, pressure within the installation is monitored, and upon detection of the drop in pressure excess of a threshold, a warning condition is initiated. This can detect even a very minor leak in the installation.

In methods embodying this aspect of the invention, the leak detection mode is preferably initiated periodically. For example, or the leak detection mode maybe initiated a once per day. Most preferably, the leak detection mode is initiated at a time at which there is little expected demand for water from the water supply installation.

In some embodiments, the leak detection mode is initiated at a predetermined time, for example, in the early hours of the morning. Alternatively, the method may include in an initial learning step a procedure in which demand for water from the water supply installation is monitored and a time is determined at which demand is minimal. The learning step may be carried out once, and may optionally be repeated. In a particularly preferred embodiment, the learning step determines a time of day at which demand is minimal, and the leak detection mode is initiated daily at that time.

In the warning condition, steps may be taken to alert a user. For example, an audible/or visual warning may be generated. Alternatively or additionally, the supply of mains water to the installation may be isolated. In preferred embodiments, differing actions may be initiated in subsequent warning conditions.

From yet another aspect, the invention provides a method of operating a water supply installation, optionally in combination with a method according to the previous aspect of the invention, in which the flow of mains water into the installation is analysed, and on the basis of that analysis, supply of mains water to the installation is maintained or interrupted.

In preferred embodiments of a method according to the last-preceding paragraph, the supply of mains water to the installation is interrupted in the event that there is a continuous flow of water into the installation for a period of time in excess of a threshold. Most preferably, in such embodiments, the supply of mains water to the installation is interrupted in the event that there is a continuous flow of water into the installation at a rate above a threshold level for a period of time in excess of a threshold.

In preferred methods embodying the invention, the supply of mains water to the installation is interrupted in the event that there is minimal or no flow detected for a period of time greater than a threshold.

Most preferably, the threshold is determined in an initial learning step in which the maximum period during which water flows continuously in normal use is determined, and the threshold is set at a value related to that period (normally, a value in excess of the said maximum period).

Embodiments of the invention will now be described in detail, by way of example, with reference to the following drawings in which:

Figure 1 is a diagrammatic representation of a water supply installation in domestic premises;

Figure 2 is a block diagram showing the main components of a control apparatus, being a first embodiment of the invention;

Figure 3 shows a front panel of control apparatus being a first embodiment of the invention;

Figure 4 is a flow diagram illustrating the sequence of operation of the embodiment of Figure; and

Figure 5 is a diagrammatic representation of a water supply installation in domestic premises being a second embodiment of the invention.

With reference first to Figure 1, a typical water supply installation in domestic premises 10 is supplied with mains water under pressure from a rising main 12. From the rising main 12, pipes 14 convey water to the various outlets including, for example, taps 16 and an automatic appliance 18. A stopcock 20 is provided in the rising main 12 in order that the water supply installation can be isolated from mains water.

In an installation embodying the present invention, in addition to the components listed in the last-preceding paragraph, there is additionally provided flow control apparatus 30. The flow control apparatus 30 is installed on the rising main 12. Included in the flow control apparatus 30 is a valve that can selectively permit or prevent flow of water in the rising main 12. First, by means of the valve, the flow control apparatus 30 can selectively connect the installation to, or isolate the installation from the supply of mains water, effectively duplicating the function of the stopcock 20.

Construction and operation of the flow control apparatus 30 will now be described in greater detail.

With reference now to Figure 2, the flow control apparatus 30 includes a housing 34. Within the housing, as described above, there is a valve 36. The valve 36 is

fed water under mains pressure by an inlet pipe 38 and delivers water to an outlet pipe 40. The inlet pipe 38 and the outlet pipe 40 are connected within the rising main 12 by suitable pipe unions (not shown).

The valve is electrically controlled. An electrical signal can be applied to a control line 42 of the valve in order to set the valve 36 in an open configuration to permit a flow of water from the inlet pipe 38 to the outlet pipe 40, or in a closed configuration to prohibit such a flow. In this embodiment, the valve is controlled by a solenoid. Alternatively, the valve 36 could be constituted by a motorised valve, which advantageously has a manual override.

As an optional feature, the valve 36 may include apparatus to resist flow of water in a direction from its outlet pipe 40 to its inlet pipe 38. That apparatus may be in the form of a double-check valve. Such apparatus is, in some legislatures, a requirement for some configurations of a water supply installation.

The apparatus further comprises a control module 46. The control module 46 contains electrical and electronic components that control operation of the flow control apparatus 30. The control module 46 has an output or which is connected to the control line 42 of the valve 36. By applying suitable signals to the output, the control module 46 can set the valve to either its open or its closed configuration. In this manner, the control module 46 is able to isolate the water supply installation from the mains supply, or to connect it to the mains supply as appropriate.

A flow switch 44 is carried on the outlet pipe 40 (it could alternatively be carried on the inlet pipe 38). The flow switch 44 has an output line 48 that is connected to the control module 46. The flow switch 44 applies a signal to its output line, which can be detected by the control module 46, when the rate of flow of water in the outlet pipe 40 exceeds a predetermined threshold. This threshold is selected to be above the rate of flow that might occur as a result of a very minor leak, for example, a dripping tap, but which is below a level that would occur when water is intentionally used.

A respective pressure transducer 50, 52 is carried on each of the inlet pipe 38 and the outlet pipe 40. Each transducer 50, 52 is operative to generate an electrical signal on an output line 54, 56 indicative of the pressure of water within the pipe to

which it is connected. Each output line 54, 56 is connected to a respective signal input of the control module 46.

The control module 46 receives a supply of electrical power from a mains input line 78. Preferably, the control module also contains a subsidiary power supply that will operate in the event of a mains failure. The subsidiary power supply might contain, for example, a rechargeable battery or an accumulator that is maintained charged while the mains supply is operational.

With reference now to Figure 3, the housing 30 includes a front panel 58 upon which user controls and indicators are mounted. In this embodiment, the front panel 58 carries four LEDs 60, 62, 64, 66 which, when energised, respectively emit green, amber, red and blue light. These are labelled, respectively, "Water Main On", "Warning", "Mains Water Off" and "Auto Off". In addition, the front panel 58 carries two liquid crystal display panels 68, 70. Also provided on the front panel 58 are an on-off switch 72 and an override switch 74. The purpose of all these controls and indicators will be described below.

The particular construction of electronic components of the control module 46 is not central to the invention and will therefore not be described in great detail. In a preferred embodiment, the control module 46 is constructed around a programmable microcontroller that is provided with suitable circuitry to enable it to interface with other components of the flow control apparatus 30. Alternatively, the control module could be constructed from discrete logic components, or could be constructed around an application-specific integrated circuit.

With reference now to Figure 4, the sequence of operation of the flow control apparatus 30 will now be described.

The diagram of Figure 4 refers to several registers that are maintained by the control module 46. These indicated in the diagram as follows:

HC = high flowrate counter

MC = medium flowrate counter

IC = idle counter

LD = leak detect

AC = amber error.

In this embodiment, the flow control apparatus 30 has three principal functions. First, it is operative to detect small leaks in a water supply installation as might, for example, be caused by a dripping tap. Second, it is operative to detect a higher volume of water flow for an extended period, such as might be caused if a tap has been left running or a pipe has burst. Third, it is operative to detect when no water has been used for an extended period, for example as might occur if premises are unoccupied, and isolate the water installation from the mains water supply.

As will be understood, the normal patterns of use of a water supply installation will vary greatly from one installation to another. Therefore, when the flow control apparatus 30 is first installed, it initially enters a learning mode in which it gathers information relating to normal patterns of water use.

In the learning mode, which may extend over several days, several items of data are recorded. First, with reference to the real-time clock, a determination is made as to the longest continuous period during which water flows in the system. This is referred to as the "maximum demand period". Also, a determination is may be made as to whether there is a five-minute period in which no water is used on any day. For domestic use, a period will typically be chosen in the early hours of the morning. For a business, the period is chosen outside the normal hours of the business. This period will be referred to as the "leak-test period". Alternatively, the leak test period may be preset to a time at which the likelihood for a demand for water is low.

The value of HC STORAGE is then set to the maximum demand period plus an additional margin for error.

When power is first applied to the control module 46, it first enters an initial isolation sequence, shown as stage 80 in Figure 4. The system then enters an outer running loop.

An assumption made when the system starts is that the water supply installation is in proper working order. Therefore, the control module 46 causes the valve 36 to

open and energises the green LED 60 (warning). The high-flow counter HC CTR is then initialised to the value HC STORAGE, and the medium-flow counter MC CTR is initiated to twice that value.

Following this, the control module enters an inner running loop, shown as stage 82 in Figure 4.

First, the override switch 74 is polled. If it is pressed, the high-flow counter is incremented, unless it has already reached a maximum value. The inner running loop is then restarted.

The rate of flow is then determined. If it is at a high rate, the high-flow counter HC-CTR is decremented, and the idle counter IC is reset. If the counter has reached zero, this means that there has been a high rate of water flow for a predetermined maximum allowable time. In this case, the control module 46 closes the valve 36 to close, thereby causing the water flow to cease, de-energises the green LED 60, and energises the red LED 64 to indicate an error condition. Otherwise, the inner running loop is restarted.

If the rate of flow is at a medium rate, the medium-flow counter MC-CTR is decremented, and the idle counter IC is reset. If the counter has reached zero, this means that there has been a medium rate of water flow for a predetermined maximum allowable time. In this case, the control module 46 closes the valve 36 to close, thereby causing the water flow to cease, de-energises the green LED 60, and energises the red LED 64 to indicate an error condition. Otherwise, the inner running loop is restarted. In view of the higher initial value of the medium-flow counter MC CTR, medium flow is allowed to persist for a longer period.

In either case, where there is significant flow continuously over an extended period, whether due to a leak or inattention by a user, the system will intervene to stop that flow. A user can operate the override switch to extend this period if it is known that there will be a demand for water for an extended period.

If neither high nor medium flow is detected, then the installation is assumed to be idle. If it has been idle for a continuous period of, for example, 24 hours then the

installation is assumed to be out of present use, for example due to the building being unoccupied. In this event, the control module 46 causes the valve 36 to close, thereby isolating the installation, de-energises the green LED 60 and energises the blue LED 66 (Auto Off) to indicate that it has done so. Thus, the system acts automatically to isolate the installation if it is not used for an extended period.

When the real-time clock indicates that the leak-test period has commenced, or when the system has been running for a predetermined period (e.g. 24 hours) a leak test is commenced, shown at stage 84 in Figure 4.

In the leak test, the control module 46 closes the valve 36 and de-energises the green LED 60. The pressure transducer 52 in the outlet pipe 40 is then used to determine the pressure in the installation. After a predetermined time (e.g. 60 seconds), the pressure is determined again, and the difference in the two pressure measurements is determined. If this exceeds a predetermined threshold, it is assumed that there is a leak in the installation. The control module 46 then causes the amber LED to illuminate.

If it is determined that a predetermined number of successive leak tests have failed, then the control module 46 assumes that there is a more serious error. It therefore de-energises the green LED 60 and closes the valve 36.

As will be appreciated, it is not essential that the user controls and indicators be placed physically close to the valve. In many cases, it will be desirable to separate them, most usually because the valve will be placed in a somewhat inaccessible location. All that is required is some means of conveying signals between the controls and indicators under control module 46. This could be achieved by means of or a direct electrical connection, or by wireless communication.

A modified installation embodying the invention is illustrated in Figure 5. The second embodiment comprises components similar to those present and the first embodiment, and has a similar method of operation. However, in this embodiment, user controls and indicators are provided on a second housing 100 located remote from the flow control apparatus 30. The user controls and indicators that are provided on the second housing 100 may be in addition to or as an alternative to user controls and indicators provided on the housing 34 of the flow control apparatus 30. On The second

housing 100 can be located in a position that is convenient for access by a user. Electrical signals are conveyed between the flow control apparatus 30 and the second housing 100 by a direct electrical connection 102.

In further alternative embodiments, signals may be conveyed between the second housing 100 and the flow control apparatus by means of a wireless link, such as by a radio signal, an infra-red signal, or any other suitable means.

Claims

1. Apparatus for use in a water supply installation, the apparatus comprising a flow interrupting device operative to connect to the installation to or isolate the installation from mains water, a controller for operating the flow interrupting device, and a flow sensor for monitoring the flow of water into the installation.

2. Apparatus according to claim 1 which operates to isolate the installation from mains water in the event that water flows into the installation for a time period greater than a threshold time.

3. Apparatus according to claim 2 which operates to isolate the installation from mains water in the event that water flows into the installation at greater than a threshold rate for a time period greater than a threshold time.

4. Apparatus according to any preceding claim further comprising a pressure detecting device operative to monitor pressure of water within the installation.

5. Apparatus according to claim 4 in which the flow interrupting device is an electrically-controlled valve.

6. Apparatus according to any preceding claim in which the flow sensor is a flow switch for detecting flow of water through the apparatus.

7. Apparatus according to claim 6 in which the flow switch is operative to generate a signal when the flow exceeds a predetermined threshold.

8. Apparatus according to any preceding claim which includes an inlet pipe and an outlet pipe, the flow interrupting device being connected between the input pipe and the output pipe.

9. Apparatus according to claim 8 including a respective pressure transducer in each of the input pipe and the output pipe.

10. Apparatus according to any preceding claim which operates to cause the flow interrupting device to isolate the installation from mains water in the event that the flow sensor detects no flow or minimal flow for a time period greater than a threshold time.

11. Apparatus for use in a water supply installation substantially as described herein with reference to the accompanying drawings.

12. A domestic water supply installation comprising apparatus according to any preceding claim installed on a rising main.

13. A method of operating a water supply installation wherein, in a leak detection mode, the installation is isolated from a supply of mains water, pressure within the installation is monitored, and upon detection of the drop in pressure excess of a threshold, a warning condition is initiated.

14. A method according to claim 13 in which the leak detection mode is initiated periodically.

15. A method according to claim 14 in which the leak detection mode is initiated a once per day.

16. A method according to any one of claims 13 to 15 in which the leak detection mode is initiated at a time at which there is little expected demand for water from the water supply installation.

17. A method according to any one of claims 13 to 16 in which the leak detection mode is initiated at a predetermined time.

18. A method according to any one of claims 13 to 17 in which the method includes an initial learning step being a procedure in which demand for water from the water supply installation is monitored and a time is determined at which demand is minimal.

19. A method according to claim 18 in which the learning step is carried out once.

20. A method according to claim 18 in which the learning step is repeated.

21. A method according to any one of claims 13 to 20 in which the learning step determines a time of day at which demand is minimal, and the leak detection mode is initiated daily at that time.

22. A method according to any one of claims 13 to 21 in which, in the warning condition, steps are taken to alert a user.

23. A method according to claim 22 in which the warning steps include generation of an audible/or visual warning.

24. A method according to any one of claims 13 to 23 in which, in the warning condition, the supply of mains water to the installation is isolated.

25. A method according to any one of claims 13 to 24 in which differing actions are initiated in subsequent warning conditions.

26. A method of operating a water supply installation in which the flow of mains water into the installation is analysed, and on the basis of that analysis, supply of mains water to the installation is maintained or interrupted.

27. A method according to claim 26 in combination with a method according to any one of claims 13 to 25.

28. A method according to claim 26 or 27 in which the supply of mains water to the installation is interrupted in the event that there is a continuous flow of water into the installation for a period of time in excess of a threshold.

29. A method according to claim 28 in which the supply of mains water to the installation is interrupted in the event that there is a continuous flow of water into the installation at a rate above a threshold level for a period of time in excess of a threshold.

30. A method according to any one of claims 26 to 29 in which the supply of mains water to the installation is interrupted in the event that there is minimal or no flow detected for a period of time greater than a threshold.

31. A method according to claim 30 in which the threshold is determined in an initial learning step in which the maximum period during which water flows continuously in normal use is determined, and the threshold is set at a value in excess of that period

32. A method of operating a water supply installation substantially as described herein with reference to the accompanying drawings.

Application No: GB 0006226.5 **Examiner:** Michael Prescott
Claims searched: 1-10 and 26-31 **Date of search:** 11 April 2001

Patents Act 1977
Search Report under Section 17

Databases searched:

UK Patent Office collections, including GB, EP, WO & US patent specifications, in:

UK Cl (Ed.S): G3N (NGA9, NGCA, NGCA4, NGCA5, NGCA5B); G4N (NCF)

Int Cl (Ed.7): E03B 7/00, 7/07 F17D 5/02, 5/06; G01M 3/28

Other: Online databases: EPODOC, JAPIO, WPI

Documents considered to be relevant:

Category	Identity of document and relevant passage		Relevant to claims
X	GB 2320351 A	(Ryford Limited) see abstract	1-3, 6-8, 12, 26, 28, 29
X	GB 2310068 A	(Chadwick, S J) see page 2 lines 1-9 and page 4 lines 7-18	1-3, 6-8, 10, 12, 26, 28-31
X	EP 0896212 A2	(Flologic, Inc.) see abstract	1, 2, 6-8, 10, 12, 26, 28, 30
X	EP 0066716 A1	(Meyer, K) see page 11 line 18 to page 12 line 7	1-3, 6-8, 12, 26, 28, 29
X	WO 95/13497 A1	(Thompson, G E) see page 9 line 3 to page 10 line 7	1, 2, 4-8, 12, 26, 28
X	US 5139044	(Otten, B J et al) see column 1 line 45 to column 2 line 68	1, 4-8, 12, 26

X	Document indicating lack of novelty or inventive step	A	Document indicating technological background and/or state of the art.
Y	Document indicating lack of inventive step if combined with one or more other documents of same category.	P	Document published on or after the declared priority date but before the filing date of this invention.
&	Member of the same patent family	E	Patent document published on or after, but with priority date earlier than, the filing date of this application.