What is claimed is:

1. A leak detection device for monitoring the status of a water-distribution block, which is connected to a water resource and constitutes a distribution pipe network,

the leak detection device comprising:

a water demand database for storing water demand of nodes of the water-distribution block;

a pipe network database for storing information about the nodes and pipes of the water-distribution block;

a data collection unit for collecting a flow rate value of a communicating tube located between the water resource and the water-distribution block for connecting them to allow water to flow through them, and pressure values of a plurality of nodes of a trunk main for the water-distribution block;

a pipe network calculation unit for estimating pressure values of the nodes of the entire water-distribution block and flow rate values of the pipes based on information stored in the water demand database and information stored in the pipe network database; and

a trunk main leak estimation unit for estimating a leak amount of the entire water-distribution block based on the flow rate value of the communicating tube and the information stored in the water demand database and estimating virtual leak amounts of the plurality of nodes of the trunk main based on the leak amount of the entire water-distribution block, the pressure values of the plurality of nodes of the trunk main as collected by the data collection unit, and the pressure values of the plurality of nodes of the trunk main as estimated by the pipe network calculation unit.

2. A leak detection device for monitoring the status of a water-distribution block, which is connected to a water resource and constitutes a distribution pipe network,

the leak detection device comprising:

a water demand database for storing water demand of nodes of the water-distribution block;

a pipe network database for storing information about the nodes and pipes of the water-distribution block;

a data collection unit for collecting a flow rate value of a communicating tube located between the water resource and the water-distribution block for connecting them to allow water to flow through them, and flow rate values of a plurality of pipes of a trunk main for the water-distribution block;

a pipe network calculation unit for estimating pressure values of nodes of the entire water-distribution block and the flow rate values of the pipes based on information stored in the water demand database and information stored in the pipe network database; and

a trunk main leak estimation unit for estimating a leak amount of the entire water-distribution block based on the flow rate value of the communicating tube and the information stored in the water demand database and estimating virtual leak amounts of the plurality of nodes of the trunk main based on the leak amount of the entire water-distribution block, the flow rate values of the plurality of pipes of the trunk main as collected by the data collection unit, and the flow rate values of the plurality of pipes of the trunk main as estimated by the pipe network calculation unit.

3. The leak detection device according to claim 2, wherein the data collection unit further collects pressure values of the plurality of nodes of the trunk main for the water-distribution block; and

wherein the trunk main leak estimation unit estimates the virtual leak amounts of the plurality of nodes of the trunk main based on the leak amount of the entire water-distribution block, the flow rate values of the plurality of pipes of the trunk main as collected by the data collection unit, the pressure values of the plurality of nodes of the trunk main as collected by the data collection unit, the flow rate values of the plurality of pipes of the trunk main as estimated by the pipe network calculation unit, and the pressure values of the plurality of nodes of the trunk main as estimated by the pipe network calculation unit.

4. The leak detection device according to claim 1, wherein the water-distribution block includes the trunk main and branches diverging from the trunk main;

wherein the nodes are provided on the trunk main and the branch;

wherein the data collection unit further collects pressure values of a plurality of nodes of the branch for the water-distribution block; and

wherein the trunk main leak estimation unit estimates virtual leak amounts of the plurality of nodes of the trunk main and the branches based on the leak amount of the entire water-distribution block, the pressure values of the plurality of nodes of the trunk main as collected by the data collection unit, the pressure values of the plurality of nodes of the branch as collected by the data collection unit, the pressure values of the plurality of nodes of the trunk main as estimated by the pipe network calculation unit, and the pressure values of the plurality of nodes of the branch as estimated by the pipe network calculation unit.

5. The leak detection device according to claim 2, wherein the water-distribution block includes the trunk main and branches diverging from the trunk main;

wherein the nodes are provided on the trunk main and the branches;

wherein the data collection unit further collects flow rate values of a plurality of pipes of the branches for the water-distribution block; and

wherein the trunk main leak estimation unit estimates virtual leak amounts of the plurality of nodes of the trunk main and the branches based on the leak amount of the entire water-distribution block, the flow rate values of the plurality of pipes of the trunk main as collected by the data collection unit, the flow rate values of the plurality of pipes of the branches as collected by the data collection unit, the flow rate values of the plurality of pipes of the trunk main as estimated by the pipe network calculation unit, and the flow rate values of the plurality of pipes of the branches as estimated the pipe network calculation unit.

6. The leak detection device according to any one of claims 1 to 3, further comprising an area forming unit and an area database,

wherein the area forming unit sets leak amounts to nodes in the water-distribution block;

wherein the trunk main leak estimation unit estimates the virtual leak amounts of the plurality of nodes of the trunk main; and

wherein the area forming unit calculates area numbers and area coefficients relating to the nodes, to which the leak amounts are set, and stores them in the area database.

7. The leak detection device according to claim 6, further comprising a spot leak estimation unit,

wherein the data collection unit further collects pressure values of nodes other than those of the trunk main of the water-distribution block; and

wherein the spot leak estimation unit estimates positions and leak amounts of individual leaks in the water-distribution block based on the virtual leak amounts of the plurality of nodes of the trunk main as estimated by the trunk main leak estimation unit, the area coefficients stored in the area database, the pressure values of the nodes other than those of the trunk main as collected by the data collection unit, and the pressure values of the nodes of the entire pipe network as estimated by the pipe network calculation unit.

8. The leak detection device according to any one of claims 1 to 3, wherein the data collection unit repeats always collecting the latest pressure values and flow rate values of the water-distribution block; and

wherein the trunk main leak estimation unit estimates the virtual leak amounts of the plurality of nodes of the trunk main based on the latest pressure values and flow rate values as collected by the data collection unit and then issues a warning when the leak amount increases rapidly.

9. The leak detection device according to claim 1 or claim 2, wherein the pipes diverging from the trunk main in the water-distribution block are equipped with valves;

wherein the data collection unit repeats always collecting the latest pressure values and flow rate values of the water-distribution block; and

wherein the trunk main leak estimation unit estimates the virtual leak amounts of the plurality of nodes of the trunk main based on the latest pressure values and flow rate values as collected by the data collection unit; and if the leak amount increases rapidly, the trunk main leak estimation unit closes the valve placed at the pipe diverging from a node of the trunk main whose leak amount has increased rapidly.

Claims

[Claim 1]

A leak detection device for monitoring the status of a water-distribution block, which is connected to a water resource and constitutes a distribution pipe network,

the leak detection device comprising:

a water demand database for storing water demand of nodes of the water-distribution block;

a pipe network database for storing information about the nodes and pipes of the water-distribution block;

a data collection unit for collecting a flow rate value of a communicating tube located between the water resource and the water-distribution block for connecting them to allow water to flow through them, and pressure values of a plurality of nodes of a trunk main for the water-distribution block;

a pipe network calculation unit for estimating pressure values of the nodes of the entire water-distribution block and flow rate values of the pipes based on information stored in the water demand database and information stored in the pipe network database;

a trunk main leak estimation unit for estimating a leak amount of the entire water-distribution block based on the flow rate value of the communicating tube and the information stored in the water demand database and estimating virtual leak amounts of the plurality of nodes of the trunk main based on the leak amount of the entire water-distribution block, the pressure values of the plurality of nodes of the trunk main as collected by the data collection unit, and the pressure values of the plurality of nodes of the trunk main as estimated by the pipe network calculation unit; and

an area forming unit for setting leak amounts to nodes in the water-distribution block, causing the pipe network calculation unit to estimate the pressure of each of the nodes and the flow rate value of the communicating tube, using the estimated values in substitute for the collected values to be used in the trunk main leak estimation unit and causing the trunk main leak estimation unit to estimate virtual leak amounts of a plurality of nodes of the trunk main, calculating area numbers relating to the nodes, to which the leak amounts are set, based on the estimated values of the virtual leak amounts, determining to which area number each of the nodes on the water-distribution block belongs, and virtually dividing the inside of the water-distribution block into a plurality of areas,

wherein the virtual leak amounts of the plurality of nodes of the trunk main estimated by the trunk main leak estimation unit are used as the leak amounts of the areas containing the nodes.

[Claim 2]

A leak detection device for monitoring the status of a water-distribution block, which is connected to a water resource and constitutes a distribution pipe network,

the leak detection device comprising:

a water demand database for storing water demand of nodes of the water-distribution block;

a pipe network database for storing information about the nodes and pipes of the water-distribution block;

a data collection unit for collecting a flow rate value of a communicating tube located between the water resource and the water-distribution block for connecting them to allow water to flow through them, flow rate values of a plurality of pipes of a trunk main for the water-distribution block, and pressure values of a plurality of nodes of a trunk main of the water-distribution block;

a pipe network calculation unit for estimating pressure values of nodes of the entire water-distribution block and the flow rate values of the pipes based on information stored in the water demand database and information stored in the pipe network database;

a trunk main leak estimation unit for estimating a leak amount of the entire water-distribution block based on the flow rate value of the communicating tube and the information stored in the water demand database and estimating virtual leak amounts of the plurality of nodes of the trunk main based on the leak amount of the entire water-distribution block, the flow rate values of the plurality of pipes of the trunk main as collected by the data collection unit, the pressure values of the plurality of nodes of the trunk main collected by the data collection unit, the flow rate values of the plurality of pipes of the trunk main as estimated by the pipe network calculation unit, and the pressure values of the plurality of nodes of the trunk main estimated by the pipe network calculation unit; and

an area forming unit for setting leak amounts to nodes in the water-distribution block, causing the pipe network calculation unit to estimate the pressure of each of the nodes and the flow rate value of the communicating tube, using the estimated values in substitute for the collected values to be used in the trunk main leak estimation unit and causing the trunk main leak estimation unit to estimate virtual leak amounts of a plurality of nodes of the trunk main, calculating area numbers relating to the nodes, to which the leak amounts are set, based on the estimated values of the virtual leak amounts, determining to which area number each of the nodes on the water-distribution block belongs, and virtually dividing the inside of the water-distribution block into a plurality of areas,

wherein the virtual leak amounts of the plurality of nodes of the trunk main estimated by the trunk main leak estimation unit are used as the leak amounts of the areas containing the nodes.

[Claim 3]

The leak detection device according to claim 1,

wherein the water-distribution block includes the trunk main and branches diverging from the trunk main,

wherein the nodes are provided on the trunk main and the branch,

wherein the data collection unit further collects pressure values of a plurality of nodes of the branch for the water-distribution block, and

wherein the trunk main leak estimation unit estimates the virtual leak amounts of the plurality of nodes of the trunk main and the branches based on the leak amount of the entire water-distribution block, the pressure values of the plurality of nodes of the trunk main as collected by the data collection unit, the pressure values of the plurality of nodes of the branches as collected by the data collection unit, the pressure values of the plurality of nodes of the trunk main as estimated by the pipe network calculation unit, and the pressure values of the plurality of nodes of the branches as estimated by the pipe network calculation unit.

[Claim 4]

The leak detection device according to claim 2,

wherein the water-distribution block includes the trunk main and branches diverging from the trunk main;

wherein the nodes are provided on the trunk main and the branch;

wherein the data collection unit further collects flow rate values of a plurality of pipes of the branch for the water-distribution block; and

wherein the trunk main leak estimation unit estimates the virtual leak amounts of the plurality of nodes of the trunk main and the branches based on the leak amount of the entire water-distribution block, the flow rate values of the plurality of pipes of the trunk main as collected by the data collection unit, the flow rate values of the plurality of pipes of the branches as collected by the data collection unit, the flow rate values of the plurality of pipes of the trunk main as estimated by the pipe network calculation unit, and the flow rate values of the plurality of pipes of the branches as estimated by the pipe network calculation unit.

[Claim 5]

The leak detection device according to claim 1 or claim 2, further comprising:

an area database; and

a spot leak estimation unit,

wherein the area forming unit stores the area numbers and area coefficients in the area database,

wherein the data collection unit further collects pressure values of nodes other than those of the trunk main for the water-distribution block, and

wherein the spot leak estimation unit estimates positions and leak amounts of individual leaks in the water-distribution block based on the virtual leak amounts of the plurality of nodes of the trunk main as estimated by the trunk main leak estimation unit, the area coefficients stored in the area database, the pressure values of the nodes other than those of the trunk main as collected by the data collection unit, and the pressure values of the nodes of the entire pipe network as estimated by the pipe network calculation unit.