Claims

1. A valve device comprising:

a valve body that defines a flow path;

a valve element capable of opening and closing a flow path of the valve body;

an operation member that operates the valve element and is moveably provided between a closed position where the valve element closes the flow path and an open position where the valve element opens the flow path, set in advance, in opening and closing directions that allow the valve element to open and close the flow path;

a main actuator that moves the operation member to the open position or the closed position; and

an adjusting actuator for adjusting a position of the operation member positioned in the open position; wherein the adjusting actuator utilizes a passive element that transforms an input electric power into expansion and contraction forces, and the adjusting actuator has a base end that is always fixed with respect to the valve body.

2. The valve device according to claim 1, wherein:

the operation member has a closed tube shape closed on the valve element side, and movably fitted to the outer periphery of the adjusting actuator from the fore end side thereof, and

the main actuator is configured to have a tube shape surrounding the outer periphery of the operation member.

3. The valve device according to claim 1 or 2, wherein:

the main actuator moves the operation member to the open position; and

the adjusting actuator adjusts the position of the operation member, that has been positioned in the open position by the main actuator, in the opening and closing directions.

4. The valve device according to claim 3, wherein

the adjusting actuator is disposed in a predetermined position with respect to the valve body, and adjusts the position of the operation member, that has reached the open position, in the opening and closing directions while receiving a force acting on the operation member at a tip portion of the adjusting actuator to regulate the movement of the operation member.

5. The valve device according to claim 4, wherein

the adjusting actuator adjusts the position of the operation member in the opening and closing directions by expansion and contraction of a total length from the tip portion to a base end portion in the opening and closing directions.

6. The valve device according to claim 4 or 5, further comprising an elastic member that continually presses the adjusting actuator toward the predetermined position, interposed between the operation member and the adjusting actuator.

7. The valve device according to any one of claims 1 to 6, wherein
the adjusting actuator is an actuator that utilizes expansion and contraction of the piezoelectric element.

8. The valve device according to claim 7, wherein
the adjusting actuator comprises a case provided with a base end portion and a tip portion in the opening and closing directions, and a piezoelectric element housed in the case and stacked between the base end portion and the tip portion, and expands and contracts a total length between the base end portion and the tip portion of the case using expansion and contraction of the piezoelectric element.

9. The valve device according to any one of claims 1 to 8, further comprising an adjusting mechanism for manually adjusting the position of the base end of the adjusting actuator with respect to the valve body, wherein the base end of the adjusting actuator is always fixed with respect to the valve body via the adjusting mechanism.

10. The valve device according to any one of claims 1 to 9, wherein
the main actuator is an actuator that uses gas pressure as a driving source.

11. A flow control method for adjusting a flow rate of a fluid using the valve device as defined in any one of claims 1 to 10.

12. A fluid control system comprising:
a plurality of fluid devices, wherein:
the fluid devices include the valve device as defined in any one of claims 1 to 10.

13. A semiconductor manufacturing method comprising a step of using the valve device as defined in any one of claims 1 to 10 for flow control of a process gas in a manufacturing process of a semiconductor device that requires a treatment process by the process gas in a sealed chamber.

14. A semiconductor manufacturing system comprising the valve device as defined in any one of claims 1 to 10 for control of a process gas in a manufacturing process of a

semiconductor device that requires a treatment process by the process gas in a sealed chamber.