temperature T, and (4) when a temperature change of the outside air is large, the gas temperature during pressure detection changes and fluctuation of the temperature detected value T increases, etc., so that even if the gas is close to an ideal gas, high flow rate measurement accuracy cannot be obtained.

[0012] On the other hand, in the method shown in Fig. 6, the valve V_1 is provided on the flow-in side of the flow rate measurement unit U_1, and via this valve, the unit U_1 is joined to the end portion of the branched connection pipe passage Ls. However, this valve V_1 is not used for flow rate measurement at all, rather, the presence of this valve V_1 poses various problems, namely, that fluid resistance increases, a drive mechanism of the valve V_1, for example, an electromagnetic valve and drive fluid piping, etc., become necessary, the component cost and assembly cost increase, an operation delay is caused by the driving performance of the valve V_1, and timing adjustment becomes necessary, etc.

[0013] In the method shown in Fig. 6, in order to measure a sum volume V of the flow passage inner volume Ve of the fluid supply line L and the branched connection pipe passage Ls and the flow passage inner volume Vt of the flow rate measurement unit U_1, the valve V_1 is opened and closed twice, and during this time, the inside of the flow rate measurement unit U_1 is vacuumed. Thus it takes too many procedures to perform flow rate measurement.

Prior Art Documents (Patent Documents)

[0014] Patent Document 1: Japanese Published Unexamined Patent Application No. 2006-337346; and

Patent Document 2: International Publication No. WO 2007/102319.

Summary ~~of The Invention~~

Problems to be Solved ~~by the Invention~~

[0015] ~~A main object~~ Example embodiments of the present ~~invention~~ application seek ~~is~~ to provide a flow rate measurement device for a flow rate controller for a gas supply device that is small in size, can be easily attached to the gas supply device, and realizes highly accurate flow rate measurement by easy operation. This ~~main object of the present invention~~ also includes providing a flow rate measurement method using the flow rate measurement device by solving the above-described problems in flow rate measurement of a flow rate controller using a conventional flow rate measurement unit U_1, that is, the valves V_1 and V_2 are provided on each of the fluid inlet side and the fluid outlet side of the flow rate measurement unit U_1. Due to provision of the inlet side valve V_1, the fluid resistance increases, the inlet side valve V_1 requires a drive mechanism including an electromagnetic valve and drive fluid piping, etc., so the assembly cost for this increases, and the drive mechanism causes operation delay due to its driving performance and requires timing adjustment, etc. Thus, the example embodiments of the present application can ~~present invention~~ solves the problem that calculation of a total inner volume V of the fluid supply line L and the branched connection pipe passage Ls and an inner volume Vt of the flow rate measurement unit U_1, takes too many operations.

[0015a] In accordance with a first aspect of the present application, there is provided a flow rate measurement device for a flow rate controller for a gas supply device, comprising: a branched pipe passage Lb having an inlet side end portion detachably joined in a branched form to an upstream portion of an on-off valve V_0 provided on an outlet end portion of a gas supply line L and an outlet side end portion of the branched pipe passage Lb is detachably joined to a gas flow-out side pipe passage that communicates with a vacuum pump VP;

an on-off valve V provided on an outlet side of the branched pipe passage Lb; a pressure detector Pd and a temperature detector Td disposed to detect a gas pressure and a gas temperature of a gas flowing in the branched pipe passage Lb; an arithmetic operation control device CP into which detection signals from the pressure detector Pd and the temperature detector Td are input, and the arithmetic operation control device arithmetically calculates a flow rate of the gas flowing in the branched pipe passage Lb; an electromagnetic valve EV that supplies a drive fluid to the on-off valve V; a drive fluid source DGS that supplies a drive fluid to the electromagnetic valve EV; an I/O board IO for the arithmetic operation control device CP; and a power source device ES.

[0015b] In accordance with a second aspect of the present application, there is provided a flow rate measurement method for a flow rate controller for a gas supply device wherein, in the gas supply device that supplies a plurality of kinds of gases to a gas use portion in a switchable manner through each of the flow rate controllers, respectively, an inlet side end portion of a branched pipe passage Lb of a flow rate measurement device U is detachably joined in a branched form to an upstream portion of an on-off valve V_0 provided on an outlet end portion of a gas supply line L, wherein the flow rate measurement device U includes the branched pipe passage Lb, an on-off valve V provided on an outlet side of the branched pipe passage Lb, a gas pressure detector Pd and a gas temperature detector Td disposed to detect a gas pressure and a gas temperature of a gas flowing in the branched pipe passage Lb, and an arithmetic operation control device CP into which detection signals from the pressure detector Pd and the temperature detector Td are input, and the arithmetic operation control device arithmetically calculates a flow rate of the gas flowing in the branched pipe passage Lb, an electromagnetic valve EV that supplies a drive fluid to the on-off valve V, a drive fluid source DGS that supplies a drive

fluid to the electromagnetic valve EV, an I/O board IO for the arithmetic operation control device CP, and a power source device ES, and wherein an outlet side end portion of the branched pipe passage Lb is connected to a gas flow-out side, and first, outlet side on-off valves V_{01} to V_{0n} of each flow rate controller of the flow rate control device and the on-off valve V_0 on the outlet end portion of the gas supply line L are closed and the on-off valve V provided on the outlet side of the branched pipe passage Lb of the flow rate measurement device U is opened, and then, only one of the outlet side on-off valves V_{01} to V_{0n} of a flow rate controller to be measured is opened to flow the gas into the branched pipe passage Lb of the flow rate measurement device U at a set flow rate, and the on-off valve V on the outlet side of the branched pipe passage Lb is closed after the gas pressure and the gas temperature in the branched pipe passage Lb become stable, a first measurement of a gas temperature T_1 and a gas pressure P_1 is performed at a time t_1 at which the gas pressure reaches a set pressure P_1, second measurement of a gas temperature T_2 and a gas pressure P_2 is then performed at a time t_2 at which the gas pressure reaches a set pressure P_2, and from the respective measured values described above, a gas flow rate Q is arithmetically calculated based on $Q = (22.4V/R \cdot \Delta t) \times (P_2/T_2 - P_1/T_1)$ (provided that V is the total inner volume of the branched pipe passage Lb and the gas supply line L, R is a gas constant, and Δt is $t_2 - t_1$).

[0015c] In accordance with a third aspect of the present application, there is provided a flow rate measurement method for a flow rate controller for a gas supply device wherein, in the gas supply device that supplies a plurality of kinds of gases to a gas use portion in a switchable manner through each of the flow rate controllers, respectively, an inlet side end portion of a branched pipe passage Lb of a flow rate measurement device U including the branched pipe passage Lb, an on-off valve V provided on the outlet side of the branched pipe

passage Lb, a gas pressure detector Pd and a gas temperature detector Td disposed to detect a gas pressure and a gas temperature of a gas flowing in the branched pipe passage Lb, and an arithmetic operation control device CP into which detection signals from the pressure detector Pd and the temperature detector Td are input, and the arithmetic operation control device arithmetically calculates a flow rate of the gas flowing in the branched pipe passage Lb, an electromagnetic valve EV that supplies a drive fluid to the on-off valve V, a drive fluid source DGS that supplies a drive fluid to the electromagnetic valve EV, an I/O board IO for the arithmetic operation control device CP, and a power source device ES is detachably joined in a branched form to an upstream portion of an on-off valve V_0 provided on an outlet end portion of a gas supply line L of the gas supply device, and an outlet side end portion of the branched pipe passage Lb is connected to a gas flow-out side, and first, outlet side on-off valves V_{01} to V_{0n} of each flow rate controller of the flow rate control device and the on-off valve V_0 on the outlet end portion of the gas supply line L are closed and the on-off valve V provided on the outlet side of the branched pipe passage Lb of the flow rate measurement device U is opened, and then, only one of the outlet side on-off valves V_{01} to V_{0n} of a flow rate controller to be measured is opened to flow the gas into the branched pipe passage Lb of the flow rate measurement device U at a set flow rate, the on-off valve V on the outlet side of the branched pipe passage Lb is closed after the gas pressure and the gas temperature in the branched pipe passage Lb become stable, a rate of gas pressure rise $\Delta P/\Delta t$ is measured, and a flow rate Q is arithmetically calculated based on $Q = \Delta P/\Delta t \times V/R \cdot T$ (provided that V is the total inner volume of the branched pipe passage Lb and the gas supply line L, R is a gas constant, Δt is a measurement time, and T is a gas temperature).

~~Means for Solving the Problem~~

[0016] ~~An invention according to Claim 1 of~~ An example embodiment of the present application is basically constituted so that a flow rate measurement device includes a branched pipe passage Lb having an inlet side end portion that is detachably joined in a branched form to an upstream portion of an on-off valve V_0 provided on ~~the~~ an outlet end portion of a gas supply line L, and an outlet side end portion of the branched pipe passage Lb is joined to a gas flow-out side. The flow rate measurement device further includes an on-off valve V provided on the outlet

side of the branched pipe passage Lb, a pressure detector Pd and a temperature detector Td, which detects a gas pressure and a gas temperature of a gas flowing in the on-off valve V, and an arithmetic operation control device CP into which detection signals from the pressure detector Pd and the temperature detector Td are input, and which arithmetically calculates a flow rate of a gas flowing in the branched pipe passage Lb, and the flow rate measurement device is detachably joined in a branched arrangement to an upstream portion of the on-off valve V_0 provided on the outlet end portion of the gas supply line L of the gas supply device GF.

[0017] ~~An invention according to Claim 2 of~~ Another example embodiment of the present application is basically constituted so that, in a gas supply device that supplies a plurality of kinds of gases to a gas use portion in a switchable manner through each of the flow rate controllers, respectively, a flow rate measurement device U including a branched pipe passage Lb, an on-off valve V provided on the outlet side of the branched pipe passage Lb, a gas pressure detector Pd and a gas temperature detector Td in the branched pipe passage Lb, and an arithmetic operation control device CP that is joined in a branched arrangement to a gas supply line L of the gas supply device, wherein the on-off valve V of the flow rate measurement device U is connected to a gas flow-out side, and first, the outlet side on-off valves V_{01} to V_{0n} of each flow rate controller of the flow rate control device, and an on-off valve V_0 on the outlet end portion of the gas supply line L, are closed and the on-off valve V of the flow rate measurement device U is opened, and then, only the outlet side on-off valve of a flow rate controller to be measured is opened to flow the gas into the flow rate measurement device U at a set flow rate, and the on-off valve V is closed after the gas pressure and the gas temperature become stable. A first measurement of a gas temperature T_1 and a gas pressure P_1 is performed at a time t_1 at which the gas pressure

reaches a set pressure P_1, a second measurement of a gas temperature T_2 and a gas pressure P_2 is performed at a time t_2 at which the gas pressure reaches a set pressure P_2, and from the respective measured values described above, a gas flow rate Q is arithmetically calculated based on $Q = (22.4V/R \cdot \Delta t) \times (P_2/T_2 - P_1/T_1)$, (provided that V is the total inner volume of the branched pipe passage Lb and the gas supply line L, R is a gas constant, Δt is $t_2 - t_1$).

[0018] ~~An invention according to Claim 3 of~~ Another example embodiment of the present application is basically constituted so that, in a gas supply device that supplies a plurality of kinds of gases to a gas use portion in a switchable manner through each of the flow rate controllers, respectively, a flow rate measurement device U including a branched pipe passage Lb, an on-off valve V provided on the outlet side of the branched pipe passage Lb, a gas pressure detector Pd and a gas temperature detector Td in the branched pipe passage Lb, and an arithmetic operation control device CP, is joined in a branched structure to a gas supply line L of the gas supply device, and the on-off valve V of the flow rate measurement device U is connected to a gas flow-out side, and first, outlet side on-off valves V_{01} to V_{0n} of each flow rate controller of the flow rate control device and an on-off valve V_0 on the outlet end portion of the gas supply line L are closed and the on-off valve V of the flow rate measurement device U is opened, and then, only the outlet side on-off valve of a flow rate controller to be measured is opened to flow the gas into the flow rate measurement device U at a set flow rate, and the on-off valve V is closed after the gas pressure and the gas temperature become stable, a rate of gas pressure rise $\Delta P/\Delta t$ is measured, and a flow rate Q is arithmetically calculated based on $Q = \Delta P/\Delta t \times V/R \cdot T$ (provided that V is the total inner volume of the branched pipe passage Lb and the gas supply line L, R is a gas constant, Δt is a measurement time, and T is a gas temperature).

[0019] ~~An invention according to Claim 4~~ Another example embodiment is constituted so that, ~~in the invention according to Claim 2 or Claim 3~~, the flow rate measurement device U includes a branched pipe passage Lb having an inlet side end portion to be joined to a gas supply line L and an outlet side end portion to be joined to a gas flow-out side, respectively, the on-off valve V provided on the outlet side of the branched pipe passage Lb, the pressure detector Pd and the temperature detector Td, which detects a gas pressure and a gas temperature of a gas flowing in the on-off valve V, an arithmetic operation control device CP into which detection signals from the pressure detector Pd and the temperature detector Td are input and which arithmetically calculates a gas flow rate of the gas flowing in the branched pipe passage Lb, an electromagnetic valve EV that supplies a drive fluid to the on-off valve V, a drive fluid source DGS that supplies a drive fluid to the electromagnetic valve EV, an I/O board IO for the arithmetic operation control device CP, and a power source device ES.

Effects of the ~~Invention~~ Example embodiments

[0020] In the present ~~invention~~ application, the above described volume V can be easily obtained based on $V = \Delta t \times Q \times R \times T/\Delta P$ (provided that Q is a flow rate, P is a fluid pressure, T is a temperature, R is a gas constant, $\Delta P/\Delta t$ is a rate of pressure rise) by measuring a rate of pressure rise at the gas flow rate Q by using a nitrogen gas, etc. That is, even if the on-off valve V_1 is not provided, the total inner volume V of the branched pipe passage Lb and the gas supply line L necessary for flow rate measurement can be easily calculated, so that the flow rate measurement operation of the flow rate controller becomes easier.

[0021] In the present ~~invention~~ application, the on-off valve V that is provided in the branched pipe passage Lb of the flow rate measurement device U is provided only on the outlet side end of the branched pipe passage Lb, so that not only can the flow rate measurement device U be downsized and structurally simplified, but also the gas flow passage resistance can be reduced. During