US 20150114470A1

(19) **United States**

(12) **Patent Application Publication**

(10) **Pub. No.: US 2015/0114470 A1**

(43) **Pub. Date: Apr. 30, 2015**

CHIENG et al.

(54) **FLOW CONTROL DEVICE AND THE METHOD FOR CONTROLLING THE FLOW THEREOF**

(71) Applicant: **National Chiao Tung University**, Hsinchu City (TW)

(72) Inventors: **Wei-Hua CHIENG**, Hsinchu City (TW); **Yi CHANG**, Hsinchu City (TW); **Shyr-Long JENG**, Hsinchu County (TW); **Chia-Chuan WANG**, Taoyuan County (TW); **Ching-Wei SHIH**, Hsinchu City (TW); **Bin-Han LUE**, Taoyuan County (TW); **Hsiang-Pin LU**, Taoyuan County (TW)

(73) Assignee: **National Chiao Tung University**, Hsinchu City (TW)

(21) Appl. No.: **14/271,674**

(22) Filed: **May 7, 2014**

(30) **Foreign Application Priority Data**

Oct. 31, 2013 (TW) 102139573

Publication Classification

(51) **Int. Cl.**

F16K 1/38 (2006.01)

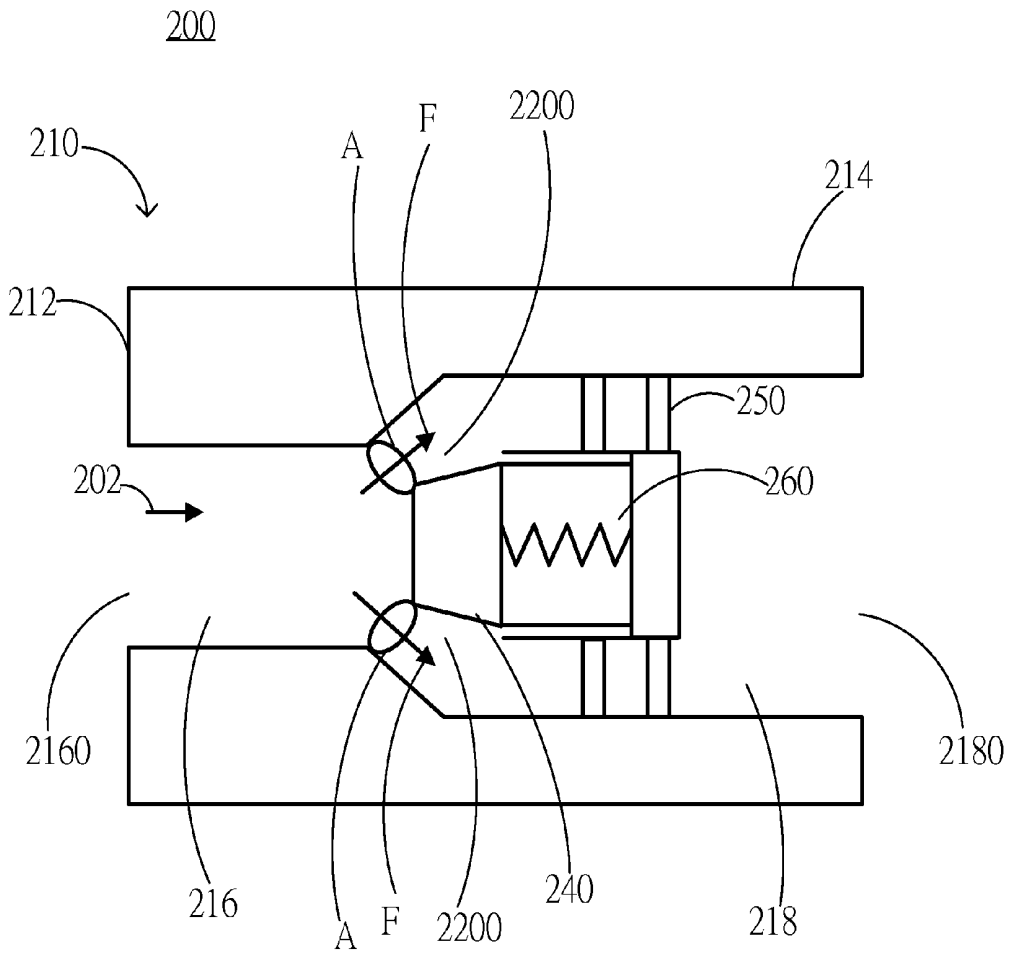
F16K 25/00 (2006.01)

(52) **U.S. Cl.**

CPC ***F16K 1/385*** (2013.01); ***F16K 25/005*** (2013.01)

(57) **ABSTRACT**

The flow control device is provided and the method for controlling the flow. A flow control device comprises: a body including a first end, opposite second end, a first flow channel and a second flow channel, a plug and a laminar flow layer accommodated in the second flow channel; a telescopic device accommodated the length of the telescopic device is adjustable, so as to control the flow of fluid flowing through the opening area in the body.



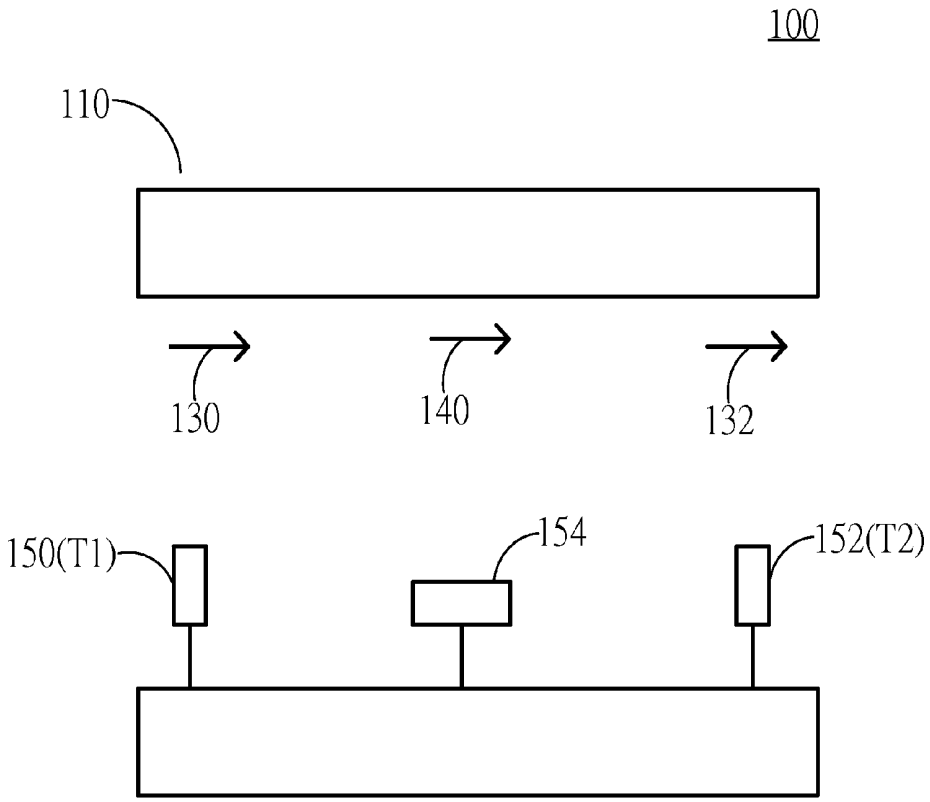


Figure 1

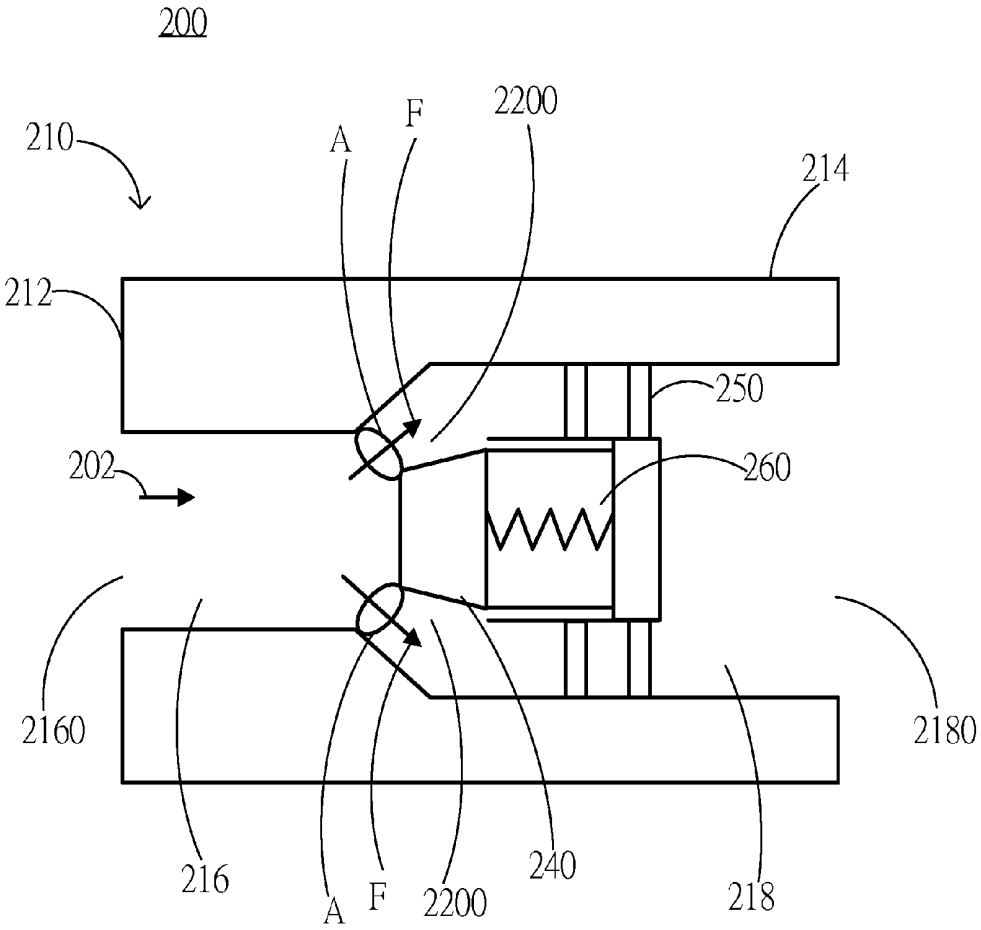

200
210
A
F
2200
214
212
250
202
260
2160
2180
216
A
F
2200
240
218

Figure 2

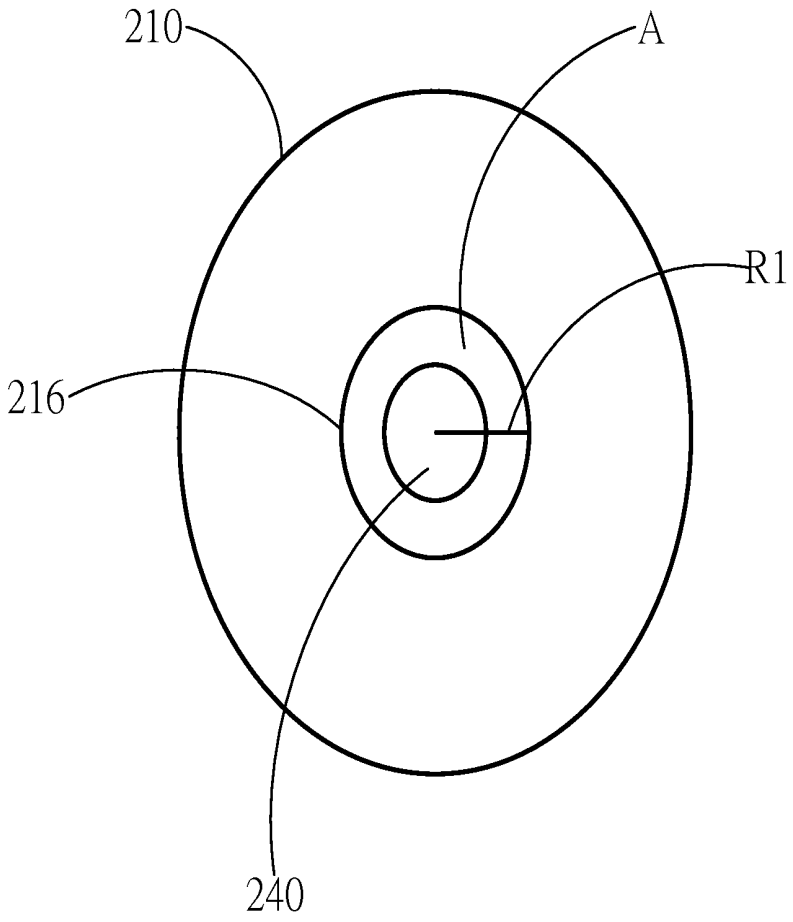


Figure 3

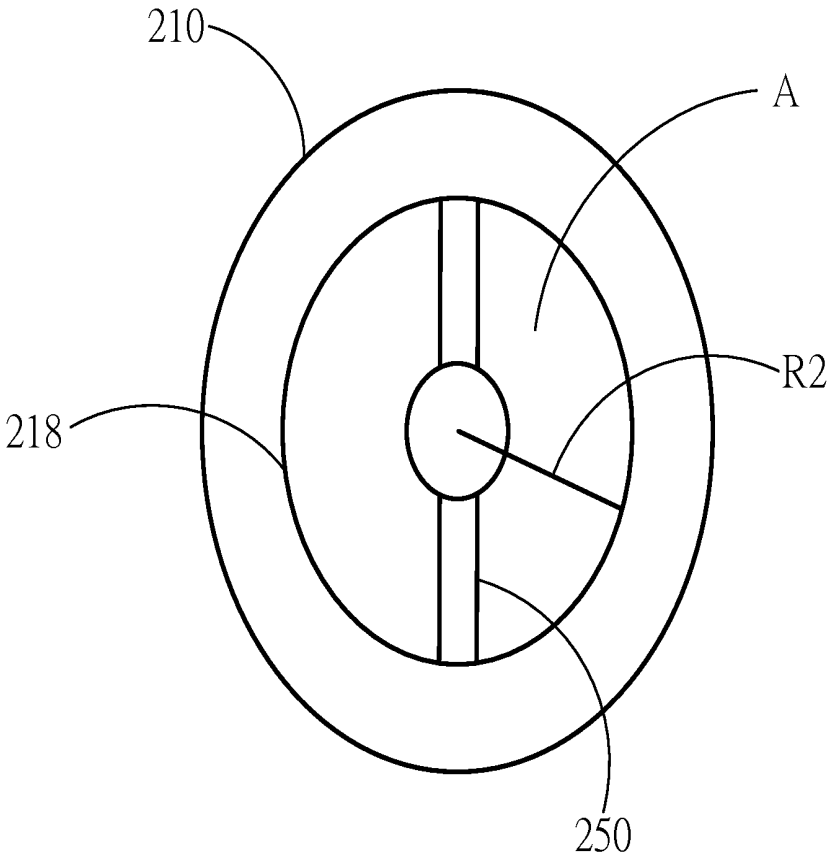


Figure 4

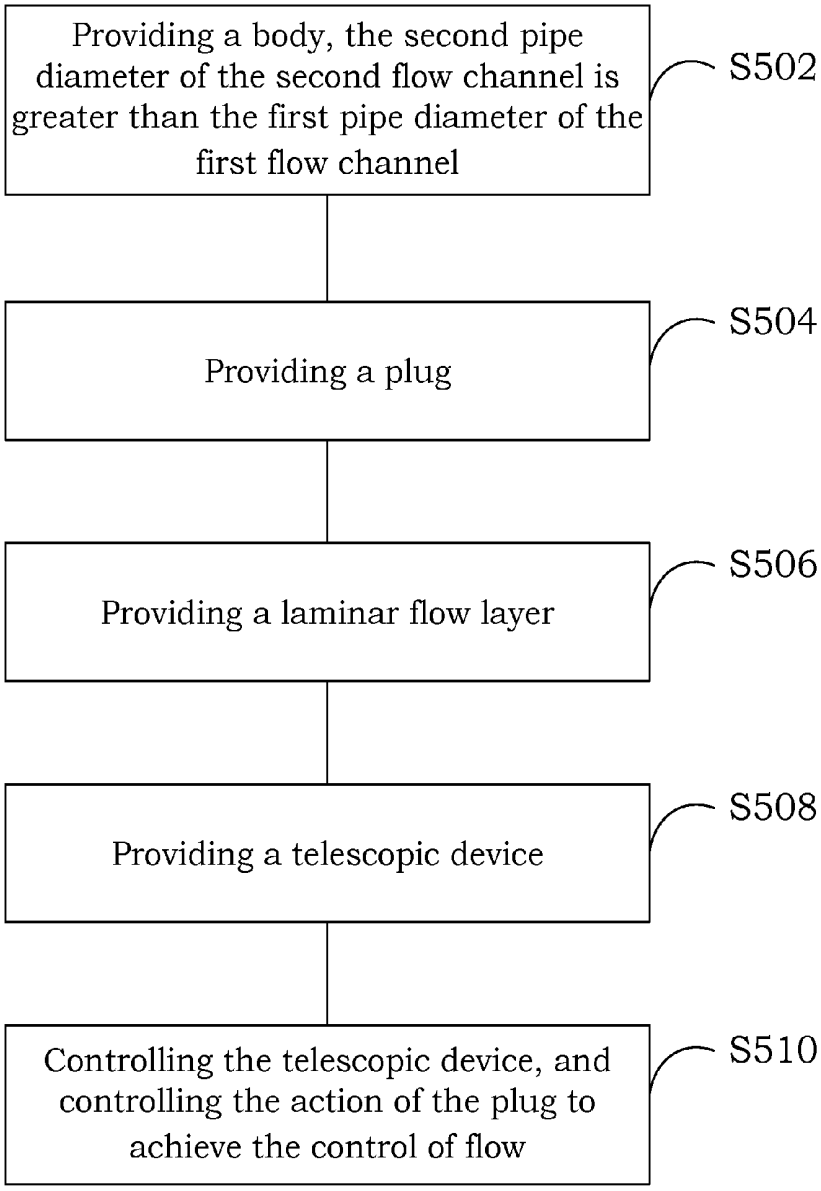

Providing a body, the second pipe diameter of the second flow channel is greater than the first pipe diameter of the first flow channel
S502
Providing a plug
S504
Providing a laminar flow layer
S506
Providing a telescopic device
S508
Controlling the telescopic device, and controlling the action of the plug to achieve the control of flow
S510

Figure 5

FLOW CONTROL DEVICE AND THE METHOD FOR CONTROLLING THE FLOW THEREOF

BACKGROUND OF THE INVENTION

[0001] 1. Field of the Invention

[0002] The present invention relates to a flow control device, more particularly to a flow control device and the method for controlling the fluid speed in the flow channel.

[0003] 2. Description of the Prior Art

[0004] Please refer to FIG. **1**, which illustrates the diagram of the thermal mass flow control device. The thermal mass flow control device **100** comprises a hollow body **110**, an upstream **130** and a downstream **132**. The fluid **140** flows from the upstream **130** to the downstream **132**. A first temperature detector **150** is installed at the upstream **130**. A second temperature detector **152** is installed at the downstream **132**. A heater **154** is installed at the center of fluid **140**. The heater **154** heats the fluid **140**. When the fluid (such as gas) passes through, it is heated by the heater **154**, and the temperature of gas will be increased. The first temperature detector **150** detects the first temperature T**1**. The second temperature detector **152** detects the second temperature T**2**. Thus, the temperature difference between the upstream and the downstream is ΔT, and the fluid flow data can be obtained from this temperature difference ΔT.

[0005] Regarding the abovementioned thermal mass flow detection method, the basic condition is that the gas must be maintained at laminar flow to obtain the correct data. Thus, the design of flow channel will be an important topic. At present, there are two design ways, one is to detect large flow in the flow channel, and the other is to measure small flow (milliliter grade) in the flow channel, in which the flow detector is placed in the flow channel.

[0006] Because the flow range applied in the flow control device has large variation, the flow control device adopting different gas flow needs different flow channel design. Thus, the production cost will be very high.

[0007] The present invention develops the flow channel design of flow control device used in vacuum equipment or epitaxy equipment. The prior art needs different flow channel for the flow control device with different flow. Thus, it will be very difficult for the user to select the flow control device and prepare the follow-up materials. The purpose of the present invention is to design a new flow channel. The flow control device adopting this flow channel design can be used in wide range of flow without changing the flow channel.

SUMMARY OF THE INVENTION

[0008] Thus, the purpose of the present invention is to provide a flow control device for adjusting flow channel with respect to different flow.

[0009] The present invention provides a flow control device for controlling the flow. A flow control device comprises: a body including a first end, opposite second end, a first flow channel and a second flow channel, the first flow channel with a first pipe diameter, the second flow channel with a second pipe diameter, the second pipe diameter is greater than the first pipe diameter, the first flow channel punching through the first end to form first opening, the second flow channel punching through the second end to form second opening, the first flow channel connecting with the second flow channel via third opening; a plug accommodated in the second flow channel; a laminar flow layer accommodated in the second flow channel and fixing on the inside wall of the second flow channel; and a telescopic device accommodated in the body and connecting between laminar flow layer and plug, the length of the telescopic device is adjustable; wherein, the telescopic device is used to control the relative motion of plug in the body, to adjust the relative position of the plug and the third opening, in order to control the opening area of the third opening, so as to control the flow of fluid flowing through the opening area in the body.

[0010] The first end is the gas inlet, and the second end is the gas outlet.

[0011] The cross-sectional shape of the first flow channel is a circle.

[0012] The cross-sectional shape of the first flow channel includes the trapezoid, rhombus, triangle or ellipse.

[0013] The cross-sectional shape of the second flow channel is a circle.

[0014] The cross-sectional shape of the second flow channel includes the trapezoid, rhombus, triangle or ellipse.

[0015] The cross-sectional shape of the plug is a circle, trapezoid, rhombus, triangle or ellipse.

[0016] The material of the plug is rubber or stainless steel.

[0017] The telescopic device is solenoid valve, pneumatic valve, spring or hydraulic valve.

[0018] Another purpose of the present invention is to provide a flow control method for a flow control device. The method comprises: providing a body including a first end, opposite second end, a first flow channel and a second flow channel, the first flow channel with a first pipe diameter, the second flow channel with a second pipe diameter, the second pipe diameter is greater than the first pipe diameter, the first flow channel punching through the first end to form first opening, the second flow channel punching through the second end to form second opening, the first flow channel connecting with the second flow channel via third opening; providing a plug accommodated in the second flow channel; providing a laminar flow layer accommodated in the second flow channel and fixing on the inside wall of the second flow channel; and providing a telescopic device accommodated in the body and connecting between laminar flow layer and plug, the length of the telescopic device is adjustable; in which the telescopic device is used to control the relative motion of plug in the body, to adjust the relative position of the plug and the third opening, in order to control the opening area of the third opening, so as to control the flow of fluid flowing through the opening area in the body.

[0019] The function of the present invention is to suitably adjust large flow and small flow of fluid in wide range of flow without changing the flow channel.

BRIEF DESCRIPTION OF THE DRAWINGS

[0020] The foregoing aspects and many of the attendant advantages of this invention will become more readily appreciated as the same becomes better understood by reference to the following detailed description, when taken in conjunction with the accompanying drawings, wherein:

[0021] FIG. **1** illustrates the cross-sectional view of the thermal mass flow control device;

[0022] FIG. **2** illustrates the cross-sectional view of the flow control device according to the present invention;

[0023] FIG. **3** illustrates the side view for the first end of the flow control device;

[0024] FIG. **4** illustrates the side view for the second end of the flow control device; and

[0025] FIG. **5** illustrates the flow diagram for the control method of fluid.

DESCRIPTION OF THE PREFERRED EMBODIMENT

[0026] Regarding the abovementioned and other technical content, feature and function of the present invention, they will be clearly described in the following preferred embodiment.

[0027] FIG. **2** illustrates the cross-sectional view of the flow control device **200** according to the present invention. The flow control device **200** is suitable for a fluid **202**, in which the fluid **202** includes the gas or the liquid. In the embodiment, the fluid **202** is a gas. The flow control device **200** comprises the body **210**, the plug **240**, the laminar flow layer **250** and the telescopic device **260**.

[0028] In the embodiment, the body **210** is a cylinder. It is noted that the body **210** of the present invention can be any shape, such as rectangle, trapezoid, rhombus, triangular and ellipse cylinder. The body **210** includes a first end **212** and an opposite second end **214**. The first end **212** is the inlet of the fluid (i.e. gas inlet end). The second end **214** is the outlet of the fluid (i.e. gas inlet end). The body **210** includes a first flow channel **216** and a second flow channel **218**. The first flow channel **216** connects with the second flow channel **218**. The first flow channel **216** is punching the first end **212** to form the first opening **2160**. The second flow channel **218** is punching the second end **214** to form the second opening **2180**. The first flow channel **216** connects with the second flow channel **218** via the third opening **2200**.

[0029] Please refer to FIG. **3** and FIG. **4**. FIG. **3** illustrates the side view for the first end **212** of the flow control device **200**, wherein the first flow channel **216** has a first pipe diameter R1. FIG. **4** illustrates the side view for the second end **214** of the flow control device **200**, wherein the second flow channel **218** has a second pipe diameter R2, and the second pipe diameter R2 is greater than the first pipe diameter R1. In FIG. **3**, the cross-sectional shape of the first flow channel **216** is a circle. In FIG. **4**, the cross-sectional shape of the second flow channel **218** is a circle. It is noted that the cross-sectional shape of the first flow channel **216** shown in FIG. **3** may be any shape, including rectangle, trapezoid, rhombus, triangular or ellipse. The cross-sectional shape of the second flow channel **218** shown in FIG. **4** may be any shape, including rectangle, trapezoid, rhombus, triangular or ellipse.

[0030] In FIG. **3**, the plug **240** is accommodated in the second flow channel **218**. In the embodiment, the cross-sectional shape of the plug **240** is a circle. It is noted that the cross-sectional shape of the plug **240** may be rectangle, trapezoid, rhombus, triangular and or ellipse to match the shape of the flow channel. The material of the plug **240** is the elastic material, such as rubber, or the rigid material, such as stainless material.

[0031] In FIG. **4**, the laminar flow layer **250** is accommodated in the second flow channel **218** and fixing on the inside wall of the second flow channel **218**. The fluid **202** shown in FIG. **2** flows through the laminar flow layer **250** to form a laminar flow state, which flows in the second flow channel **218** shown in FIG. **4** to get more precise measurement.

[0032] In FIG. **2**, the telescopic device **260** is accommodated in the body **210** and connecting the laminar flow layer **250** and the plug **240**. The telescopic device **260** parallels to the first flow channel **216** or the second flow channel **218** to adjust its length. In the embodiment, the telescopic device **260** is spring. It is noted that the telescopic device **260** of the present invention is solenoid valve, pneumatic valve or hydraulic valve. The flow control device **200** controls the relative action of plug **240** in the first flow channel **216** or the second flow channel **218** via controlling the length of the telescopic device **260**.

[0033] In FIG. **2**, the flow control device **200** controls the length of the telescopic device **260**, to control the relative action of plug **240** in the body **210**, in order to adjust the relative position of the plug **240** and the third opening **2200**, so as to control the opening area A of the third opening **2200**. By controlling the flow F of the fluid **202** flows through the opening area A, it is able to control the flow F of the fluid **202** flows from the first flow channel **216** to the second flow channel **218**.

[0034] In an embodiment shown in FIG. **2**, when the flow channel is designed to measure small flow (such as milliliter grade), the flow control device **200** controls the stretch of the telescopic device **260** and control the plug **240** in the second flow channel **218** moving from the second end **214** toward the first end **212**. At this time, the relative position between the plug **240** and the third opening **2200** is closer and closer. The plug **240** will shield more opening area A of the third opening **2200**, in order to control the opening area A of the third opening **2200**, so as to reduce the flow F of the fluid **202** in the body **210** flows through the opening area A. Via the abovementioned mechanism, the flow control device **200** can control the flow of the fluid **202** flows from the first flow channel **216** to the second flow channel **218**.

[0035] In another embodiment shown in FIG. **2**, when the flow channel is designed to measure large flow (such as over 2 liters), the flow control device **200** controls the contraction of the telescopic device **260**, and controls the plug **240** in the second flow channel **218** moving from the first end **212** toward the second end **214**. At this time, the relative position between the plug **240** and the third opening **2200** is longer. The plug **240** will shield less opening area A of the third opening **2200**, in order to control the opening area A of the third opening **2200**, so as to increase the flow F of the fluid **202** in the body **210** flows through the opening area A. Via the abovementioned mechanism, the flow control device **200** can control the flow of the fluid **202** flows from the first flow channel **216** to the second flow channel **218**.

[0036] Please refer to FIG. **2**. The flow control method of the present invention is suitable for the flow control device **200**. This flow control device **200** is suitable for a fluid **202**, in which the fluid **202** includes the gas or the liquid. In the embodiment, the body **210** is a cylinder. It is noted that the body **210** of the present invention can be any shape, such as rectangle, trapezoid, rhombus, triangular and ellipse cylinder. The body **210** includes a first end **212** and an opposite second end **214**. The first end **212** is the inlet of the fluid (i.e. gas inlet end). The second end **214** is the outlet of the fluid (i.e. gas inlet end). The body **210** includes a first flow channel **216** and a second flow channel **218**. The first flow channel **216** connects with the second flow channel **218**. The first flow channel **216** is punching the first end **212** to form the first opening **2160**. The second flow channel **218** is punching the second end **214** to form the second opening **2180**. The first flow channel **216** connects with the second flow channel **218** via the third opening **2200**.

[0037] Please refer to FIG. **3** and FIG. **4**. FIG. **3** illustrates the side view for the first end **212** of the flow control device **200**, in which the first flow channel **216** has a first pipe diameter R**1**. FIG. **4** illustrates the side view for the second end **214** of the flow control device **200**, in which the second flow channel **218** has a second pipe diameter R**2**, and the second pipe diameter R**2** is greater than the first pipe diameter R**1** (shown in FIG. **3**). The cross-sectional shape of the first flow channel **216** is a circle (shown in FIG. **3**). The cross-sectional shape of the second flow channel **218** is a circle (shown in FIG. **4**). It is noted that the cross-sectional shape of the first flow channel **216** shown in FIG. **3** may be any shape, including rectangle, trapezoid, rhombus, triangular or ellipse. The cross-sectional shape of the second flow channel **218** shown in FIG. **4** may be any shape, including rectangle, trapezoid, rhombus, triangular or ellipse.

[0038] FIG. **5** illustrates the flow diagram for the control method of fluid. A body **210** is provided by Step S**502** first. A plug **240** is provided by Step S**504**. The plug **240** is accommodated in the second flow channel **218**. In the embodiment, the cross-sectional shape of the plug **240** is a circle. It is noted that the cross-sectional shape of the plug **240** may be rectangle, trapezoid, rhombus, triangular and or ellipse to match the shape of the flow channel. The material of the plug **240** is the elastic material, such as rubber, or the rigid material, such as stainless material.

[0039] In FIG. **5**, a laminar flow layer **250** is provided by Step S**506**. The laminar flow layer **250** is accommodated in the second flow channel **218** and fixing on the inside wall of the second flow channel **218**. The fluid **202** flows through the laminar flow layer **250** to form a laminar flow state, which flows in the second flow channel **218** obtain get more precise measurement.

[0040] In FIG. **5**, a telescopic device **260** is provided by Step **5508**. The telescopic device **260** is accommodated in the body **210** and connected the laminar flow layer **250** and the plug **240**. The telescopic device **260** parallels to the first flow channel **216** or the second flow channel **218** to adjust its length. In the embodiment, the telescopic device **260** is spring. It is noted that the telescopic device **260** of the present invention is solenoid valve, pneumatic valve or hydraulic valve. The flow control device **200** controls the relative action of plug **240** in the first flow channel **216** or the second flow channel **218** via controlling the length of the telescopic device **260**.

[0041] In Step **5510** of FIG. **5**, the flow control device **200** controls the length of the telescopic device **260**, to control the relative action of plug **240** in the body **210**, in order to adjust the relative position of the plug **240** and the third opening **2200**, so as to control the opening area A of the third opening **2200**. By controlling the flow F of the fluid **202** flows through the opening area A, it is able to control the flow F of the fluid **202** flows from the first flow channel **216** to the second flow channel **218**.

[0042] In an embodiment shown in FIG. **2**, when the flow channel is designed to measure small flow (such as milliliter grade), the flow control device **200** controls the stretch of the telescopic device **260** and control the plug **240** in the second flow channel **218** moving from the second end **214** toward the first end **212**. At this time, the relative position between the plug **240** and the third opening **2200** is closer and closer. The plug **240** will shield more opening area A of the third opening **2200**, in order to control the opening area A of the third opening **2200**, so as to reduce the flow F of the fluid **202** in the body **210** flows through the opening area A. Via the abovementioned mechanism, the flow control device **200** can control the flow of the fluid **202** flows from the first flow channel **216** to the second flow channel **218**.

[0043] In another embodiment shown in FIG. **2**, when the flow channel is designed to measure large flow (such as over 2 liters), the flow control device **200** controls the contraction of the telescopic device **260**, and controls the plug **240** in the second flow channel **218** moving from the first end **212** toward the second end **214**. At this time, the relative position between the plug **240** and the third opening **2200** is longer. The plug **240** will shield less opening area A of the third opening **2200**, in order to control the opening area A of the third opening **2200**, so as to increase the flow F of the fluid **202** in the body **210** flows through the opening area A. Via the abovementioned mechanism, the flow control device **200** can control the flow of the fluid **202** flows from the first flow channel **216** to the second flow channel **218**.

[0044] Through the abovementioned flow control device and method for controlling the flow and the combination of different flow channel, control the telescopic device to drive the plug **240**, in order to suitably adjust large flow and small flow of fluid in wide range of flow without changing the flow channel. It can simplify the materials prepared for the device instead of preparing a lot of flow control devices for different flow.

[0045] It is understood that various other modifications will be apparent to and can be readily made by those skilled in the art without departing from the scope and spirit of this invention. Accordingly, it is not intended that the scope of the claims appended hereto be limited to the description as set forth herein, but rather that the claims be construed as encompassing all the features of patentable novelty that reside in the present invention, including all features that would be treated as equivalents thereof by those skilled in the art to which this invention pertains.

What is claimed is:

1. A flow control device, comprising:

a body including a first end, opposite second end, the body having a first flow channel and a second flow channel, the first flow channel with a first pipe diameter, the second flow channel with a second pipe diameter, the second pipe diameter is greater than the first pipe diameter, the first flow channel punching through a first end to form a first opening, the second flow channel punching through a second end to form a second opening, the first flow channel connecting with the second flow channel via a third opening;

a plug accommodated in the second flow channel;

a laminar flow layer accommodated in the second flow channel and fixed on an inside wall of the second flow channel; and

a telescopic device accommodated in the body and connecting between the laminar flow layer and the plug, a length of the telescopic device is adjustable;

wherein the telescopic device being used to control a relative motion of the plug in the body, to adjust the relative position of the plug and the third opening, in order to control the opening area of the third opening, so that control a flow of a fluid flowing through the opening area in the body.

2. The method according to claim **1**, wherein the second flow channel is greater than the first flow channel, the telescopic device being used to control the relative motion of the

plug in the body, to adjust the relative position of the plug and the third opening, in order to control the opening area of the third opening, so that control the flow of fluid flowing through the opening area in the body.

3. The device according to claim **1**, wherein the fluid is selected from the group consisting of gas and liquid.

4. The device according to claim **1**, wherein the cross-sectional of the first flow channel is a circle.

5. The device according to claim **1**, wherein the cross-sectional shape of the first flow channel is selected from the group consisting of the trapezoid, rhombus, triangle and ellipse.

6. The device according to claim **1**, wherein the cross-sectional shape of the second flow channel is a circle.

7. The device according to claim **1**, wherein the cross-sectional shape of the second flow channel is selected from the group consisting of the trapezoid, rhombus, triangle and ellipse.

8. The device according to claim **1**, wherein the cross-sectional shape of the plug is selected from the group consisting of circle, trapezoid, rhombus, triangle and ellipse.

9. The device according to claim **1**, wherein the material of the plug is selected from the group consisting of rubber stainless steel.

10. The device according to claim **1**, wherein the telescopic device is selected from the group consisting of solenoid valve, pneumatic valve, spring or hydraulic valve.

11. A flow control method for a flow control device, comprising:

providing a body including a first end, opposite second end, the body having a first flow channel and a second flow channel, the first flow channel with a first pipe diameter, the second flow channel with a second pipe diameter, the second pipe diameter is greater than the first pipe diameter, the first flow channel punching through the first end to form a first opening, the second flow channel punching through the second end to form a second opening, the first flow channel connecting with the second flow channel via a third opening;

providing a plug accommodated in the second flow channel;

providing a laminar flow layer accommodated in the second flow channel and fixed on an inside wall of the second flow channel; and

providing a telescopic device accommodated in the body and connecting between the laminar flow layer and the plug, a length of the telescopic device is adjustable;

wherein the telescopic device is used to control the relative motion of the plug in the body, to adjust the relative position of the plug and the third opening, in order to control the opening area of the third opening, so that control a flow of a fluid flowing through the opening area in the body.

12. The method according to claim **10**, wherein the cross-sectional shape of the first flow channel is selected from the group consisting of the circle, trapezoid, rhombus, triangle and ellipse.

13. The method according to claim **11**, wherein the cross-sectional shape of the second flow channel is selected from the group consisting of the circle, trapezoid, rhombus, triangle and ellipse.

14. The method according to claim **11**, wherein the cross-sectional shape of the plug is selected from the group consisting of a circle, trapezoid, rhombus, triangle and ellipse.

15. The method according to claim **11**, wherein the material of the plug is selected from the group consisting of rubber and stainless steel.

16. The method according to claim **11**, wherein the telescopic device is selected from the group consisting of solenoid valve, pneumatic valve, spring or hydraulic valve.

* * * * *