

Proportioning valves bench test procedures for automobiles

1. Scope

This standard specifies proportioning valves bench test procedures for a device which controls the proportioning of the pressure of an automobile brake that functions properly, to the front and the rear (hereinafter referred to as "control device").

Remark: Applicable standards for this standard are shown below.

JIS D 1601	Vibration testing method for automobile parts
JIS D 0203	Method of moisture, rain and spray test for automobile parts
JIS D 0207	General rules of dust test for automobile parts
JIS K 2233	Non-petroleum base motor vehicle brake fluids
JIS Z 2371	Methods of salt spray testing
JIS Z 8703	Standard atmospheric conditions for testing

2. Classification of control device

The classification of applicable control devices shall be in accordance with Table 1.

Table 1 Classification of control devices

Classification	Feature
Proportioning valve	A valve which reduces the output pressure against the input pressure with a fixed ratio
Inertia Proportioning valve	A proportioning valve which varies the output pressure in response to deceleration which is produced corresponding to vehicle load
Load sensing proportioning valve	A proportioning valve which varies the output pressure in response to displacement of the car height corresponding to movable load, or pressure change in the air suspension, etc.

3. Type of control device

The type of control device shall be in accordance with Table 2.

Table 2 Type of control device

Type	Division
Hydraulic control device	Class 1 A control device which is used under normal hydraulic operating condition
	Class 2 A control device which is used under high pressure hydraulic operating condition
Pneumatic control device	Class 3 A control device which is used under pneumatic operating condition

4. Definitions

Definitions of major terms used in this standard shall be as follows.

(1) Split point

Change point at which the control device starts to operate. (Refer to Fig. 1.)

(2) Ratio

Ratio of increase in output pressure to increase in input pressure.

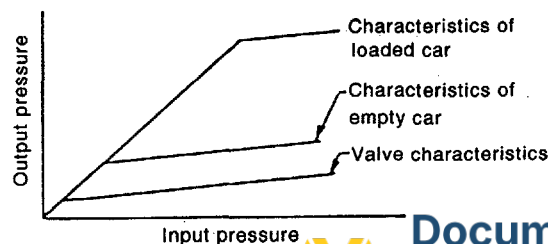
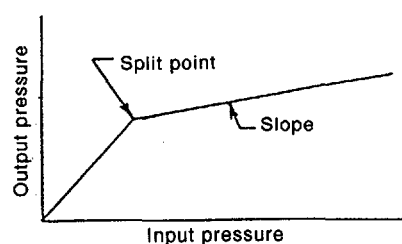
(3) Valve characteristics

Characteristics in case the split point is made minimum in the control device in which the split point is made variable in response to movable load.

(4) Empty car characteristics

Characteristics of the control device which are approximated to an empty state of a

Fig. 1 Example of input and output characteristics



vehicle brake distribution, or characteristics of the proportioning valve, in the control device in which the characteristics are made variable in response to movable load.

(5) Loaded car characteristics

Characteristics of the control device which are approximated to a loaded state of a vehicle brake distribution, in the control device in which the characteristics are made variable in response to movable load.

(6) Charged pressure

Pressure which is charged by detecting deceleration in the control chamber of inertia proportioning valve.

(7) Required fluid quantity

Amount of brake fluid to be fed, which is required to apply fluid pressure in the body to the predetermined fluid pressure.

(8) Output side load

Required fluid quantity or capacity for pressure of the rear brake system which is mounted on the output side of the control device.

5. Common items

5.1 Test place

Unless otherwise specified, the test place shall be a place at normal temperature and normal humidity as specified in **JIS Z 8703**.

5.2 Sample

Unless otherwise specified, the sample shall be a new item which functions normally and which is assembled at random with parts that have normal functions.

5.3 Test Equipment

Unless otherwise specified, the devices and instruments to be used in tests shall be as follows.

(1) Pressure device for measuring characteristics

A pressure device which is used in a test in which the control device is manually pressurized; This pressure device shall be capable of applying predetermined load to the control device in one process. (Refer to **Fig. 2-1, 2-2, and 2-3**)

(2) Pressure device for endurance test

A pressure device which is used in a test in which the control device is automatically and repeatedly pressurized; This

pressure device shall be capable of applying predetermined load to the control device in one process. (Refer to **Fig. 3**.)

(3) Fitting jig

Unless otherwise specified, a fitting jig to be used in the tests shall be capable of fixing the position, mounting angle, adjustment, etc. of the control device in the mounting state equivalent to that in a real vehicle.

Also, in the control device in which the characteristics are made variable according to movable loads, a fitting jig to be used shall be capable of reproducing the typical characteristics (i.e. valve characteristics, empty car characteristics and loaded car characteristics). (Refer to **Fig. 4**.)

(a) Fitting jig for proportioning valve

Unless otherwise specified, a fitting jig which is capable of fixing in a mounting state equivalent to that in a real vehicle.

(b) Fitting jig for inertia proportioning valve

Unless otherwise specified, a fitting jig which is capable of freely setting the mounting angle of the control device.

(c) Fitting jig for load sensing proportioning valve

Unless otherwise specified, a fitting jig which is capable of relatively displacing a mounting position of the sensor section so as to meet the mounting state on a real vehicle after the valve body is fixed.

Fig. 2-1 Example of pressure device for measuring characteristics
(Class 1 for hydraulic control devices is shown.)

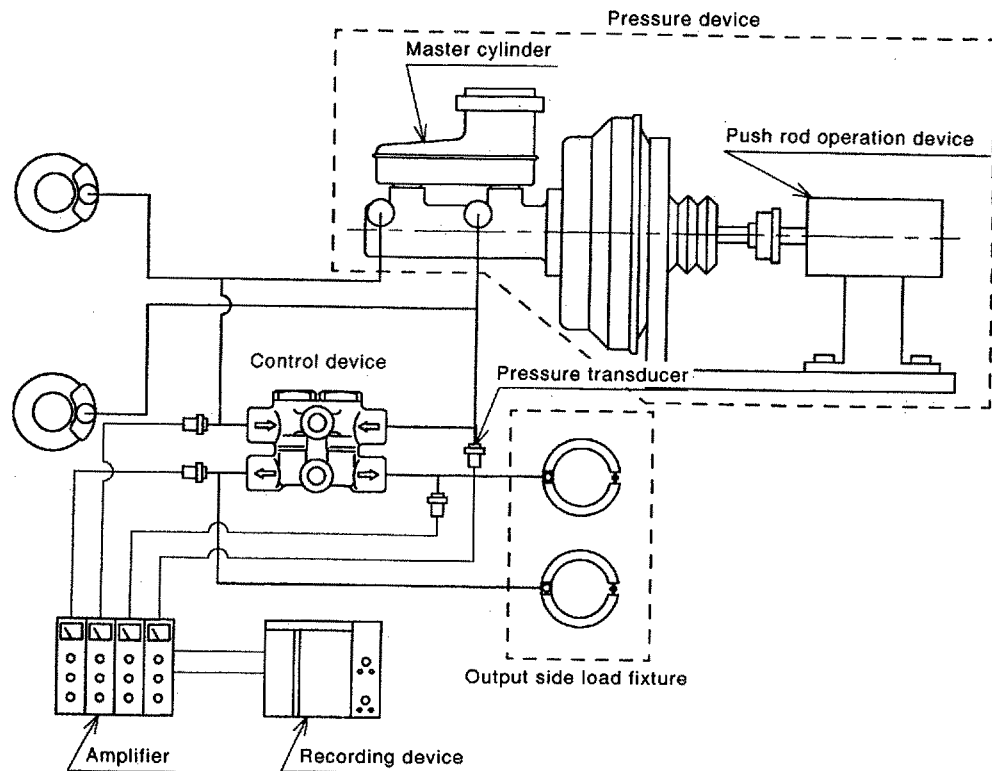


Fig. 2-2 Example of pressure device for measuring characteristics
(Class 3 for pneumatic control devices is shown.)

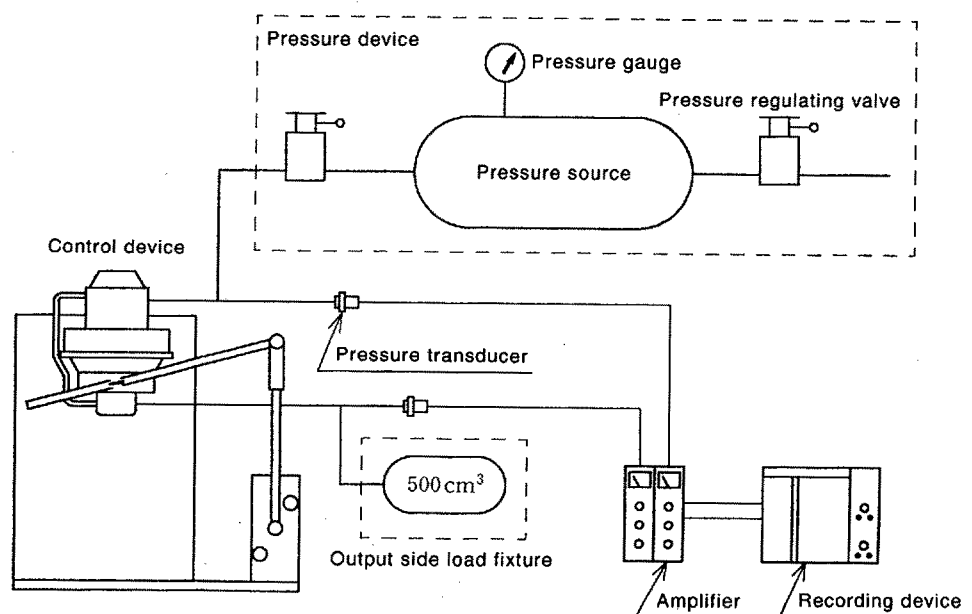


Fig. 2-3 Example of pressure device for measuring high temperature and low temperature characteristics (Class 1 for hydraulic control devices is shown.)

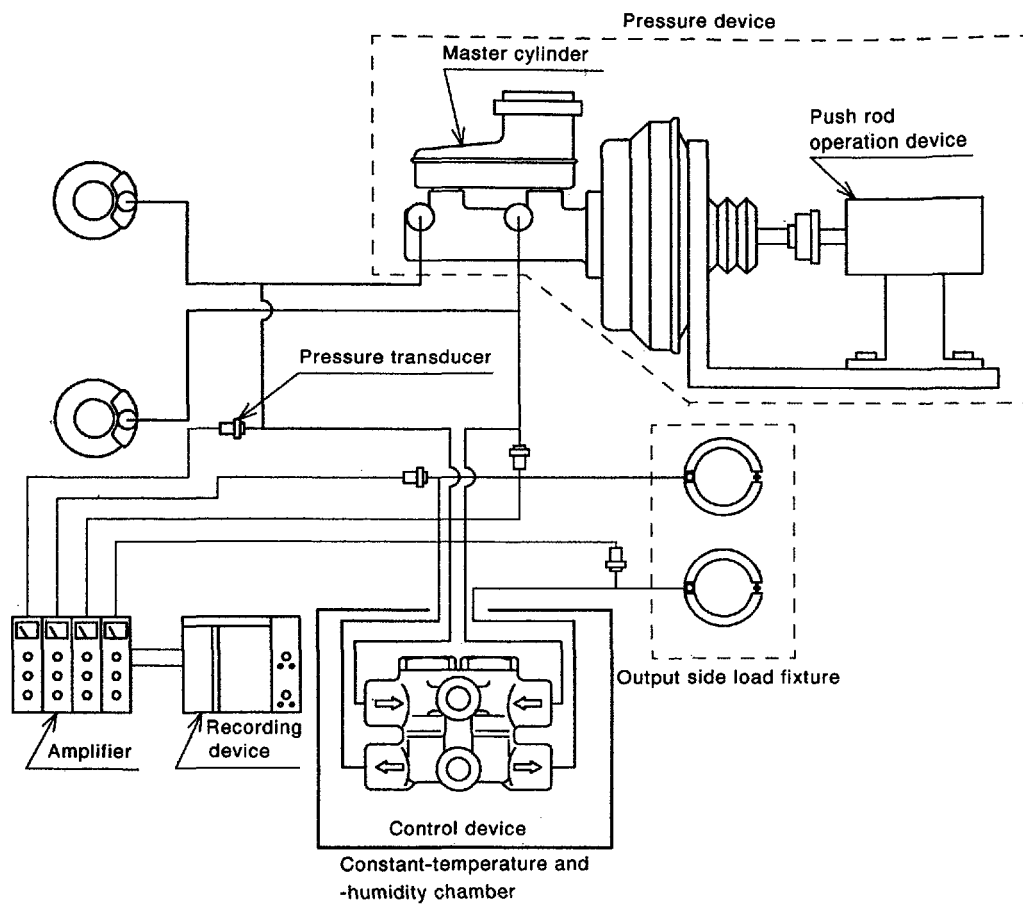


Fig. 3 Example of pressure device for endurance

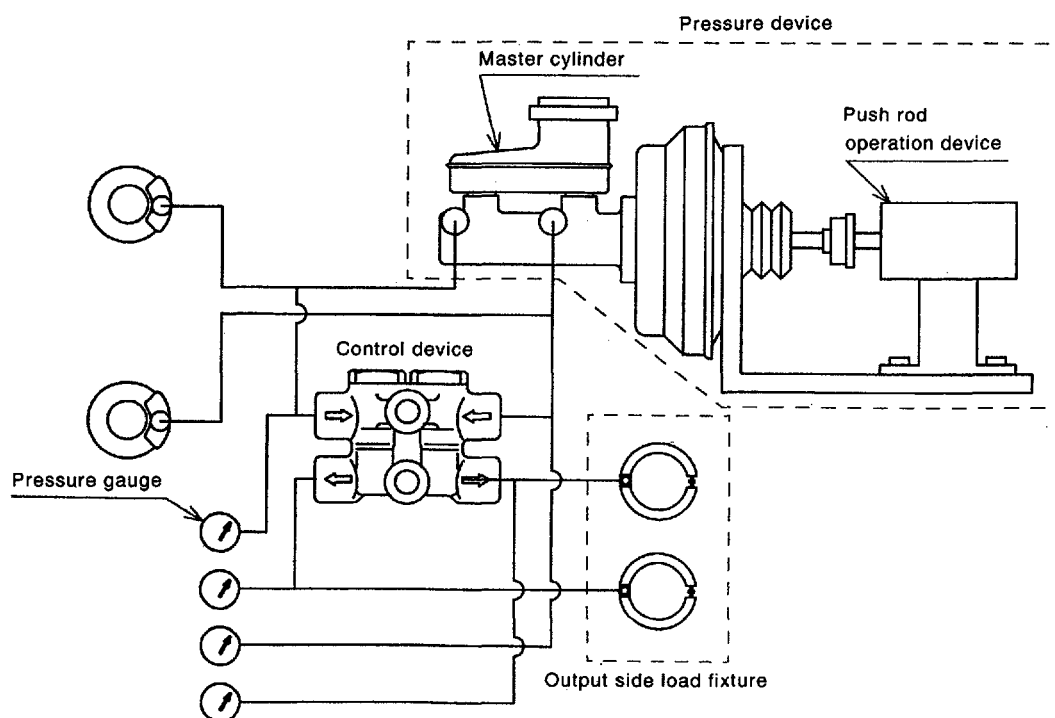
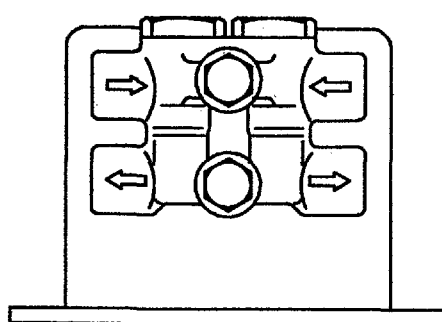
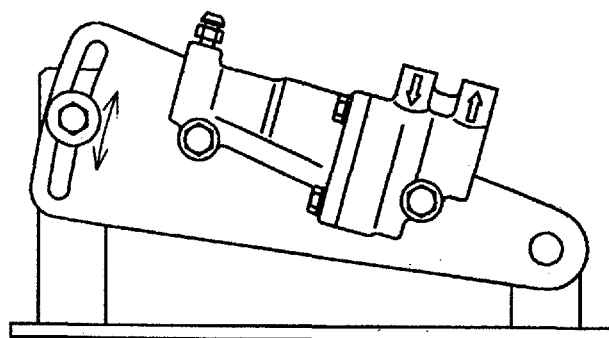


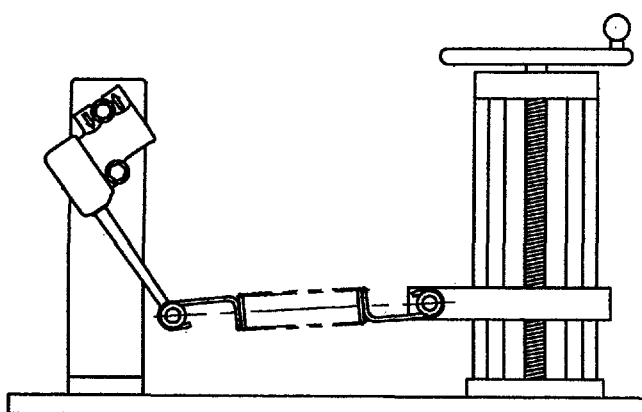
Fig. 4 Example of fitting jig



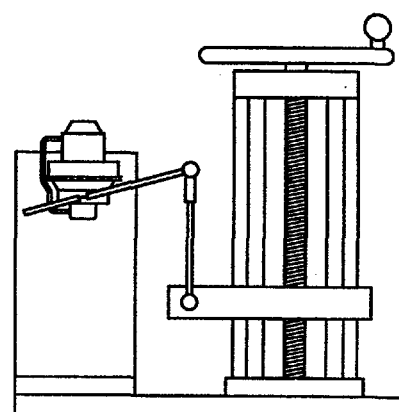
Proportioning valve



Inertia proportioning valve



Load sensing proportioning valve (Hydraulic)



Load sensing proportioning valve (Pneumatic)

(4) Output side load

Unless otherwise specified, the output side load fixture shall be matched as far as possible to the load of a real vehicle. In case of a pneumatic control device, it shall be a tank of approx. 500 cm³.

(5) Constant-temperature and-humidity chamber

A thermostatic chamber or a constant-temperature and-humidity chamber shall be used as required.

(6) Control device integrated with other equipment

In case of the control device integrated with master cylinder, etc., tests shall be conducted in the state in which the control device is integrated with dedicated jig or master cylinder.

5.4 State of control device

Unless otherwise specified, the state of the control device in testing shall be the one in which the control device is adjusted to its typical

state. The method of adjusting to the typical state of the control device shall be in accordance with the following.

(1) Proportioning valve

This valve shall be adjusted to the state of an empty car.

(2) Inertia proportioning valve

This valve shall be fixed on the fitting jig specified in 5.3 (3) at the mounting angle on a real vehicle.

(3) Load sensing proportioning valve

The control device shall be adjusted to show the state of an empty car in the state of the valve mounted on the fitting jig specified in 5.3 (3).

5.5 Test fluid

The brake fluid to be used in the test shall be Class 3 or Class 4 specified in JIS K 2233, or those agreed by the parties concerned.

6. Test items

Test items for the control device shall be as shown in **Table 3**. The test items and their outline are shown in **Attached table**.

6.1 Normal temperature operation characteristics test procedure

6.1.1 Purpose

This test shall be conducted to examine the operation characteristics of the control device in the normal temperature atmosphere.

6.1.2 Test equipment

The devices and instruments to be used in the test shall be as follows.

(1) Pressure device

The pressure device for measuring characteristics specified in **5.3 (1)**.

(2) Fitting jig

The fitting jig specified in **5.3 (3)**.

(3) Output side load

The output side load specified in **5.3 (4)**.

6.1.3 State of control device

Unless otherwise specified, the state of the control device shall be the state specified in **5.4**.

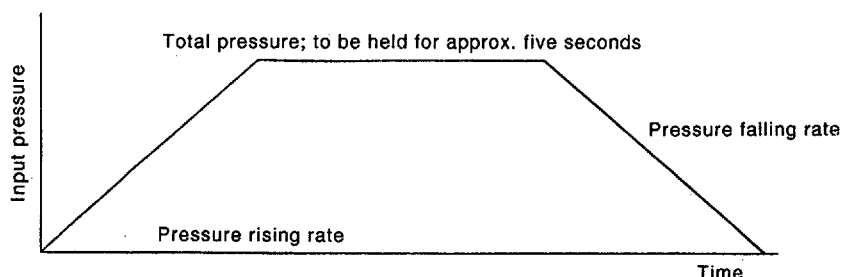
6.1.4 Test procedure

The test procedure shall be as follows.

- (1) Fix the control device on the fitting jig. In case of a hydraulic control device, bleed air sufficiently.
- (2) Increase the input pressure until it reaches a total pressure and then decrease it to the atmospheric pressure. Repeat this operation several times and then confirm that the output pressure goes up and down smoothly. Then conduct the following tests.
- (3) Depending on the type of pressure generator for which the control device is used, measure the output pressure against the input pressure when pressure is applied under the conditions shown in **Table 4** (hereinafter referred to as "input and output characteristics").
- (4) The procedure for reproducing the typical characteristics of the inertia proportioning valve shall be as follows.
 - (a) Set the control device at the same mounting angle as that for a real vehicle.
 - (b) Apply the input pressure up to a charged pressure at which the characteristics of an empty car are shown, and then maintain it.
 - (c) Incline the mounting angle of the control device to a negative side (example: -3° or below).
 - (d) Apply the input pressure up to a total pressure.

Table 3 Test item

No.	Hydraulic control device	Pneumatic control device
1	Normal temperature operation characteristics test	Normal temperature operation characteristics test
2	High temperature operation characteristics test	High temperature operation characteristics test
3	Low temperature operation characteristics test	Low temperature operation characteristics test
4	Airtightness test	Airtightness test
5	Vacuum retention test	
6	Low temperature leakage test	Low temperature leakage test
7	Required fluid quantity test	
8	Pressure proof strength test	Pressure proof strength test
9	Normal temperature operation endurance test	Normal temperature operation endurance test
10	High temperature operation endurance test	
11	High pressure operation endurance test	
12	Sensor section operation endurance test	Sensor section operation endurance test
13	Vibration endurance test	Vibration endurance test
14	Salt spray test	Salt spray test
15	Water proof test	
16		Dust test

Table 4 Conditions of normal temperature operation characteristics

Type of control device		Pressure rising rate, MPa/s	Total pressure, MPa	Pressure falling rate, MPa/s
Hydraulic control device	Class 1	Approx. 4	14±1	Approx. 4
	Class 2	Approx. 4	15±1	Approx. 4
Pneumatic control device	Class 3	Approx. 0.05	0.7±0.04	Approx. 0.05

- (5) In the control device in which characteristics are variable in response to movable load, change the typical state in 5.4 as required and then measure the input and output characteristics (i.e. loaded car characteristics, valve characteristics, etc.). In case of the inertial proportioning valve, change the charged pressure and then measure the input and output characteristics.
- (6) In the control device which has a structure of changing the proportioning characteristics at the time of failure/loss of one system, measure the input and output characteristics at the time of failure/loss of one system as required.
- (7) In case where the operability at the time of fast operation is particularly required, measure the input and output characteristics when a pressure rising speed is changed as required.

6.1.5 Records

- (1) Input and output characteristics.
- (2) Any other noteworthy items.

6.2 High temperature operation characteristics test procedure

6.2.1 Purpose

This test shall be conducted to examine the operation characteristics of the control device in high temperature atmosphere.

6.2.2 Test equipment

The devices and instruments to be used in the test shall be as follows.

- (1) **Pressure device**
A pressure device for measuring characteristics specified in 5.3 (1).
- (2) **Fitting jig**
The fitting jig specified in 5.3 (3).
- (3) **Output side load**
Unless otherwise specified, output side load specified in 5.3 (4).
- (4) **Thermostatic chamber**
The thermostatic chamber shall be capable of maintaining the control device in high temperature atmosphere.

6.2.3 State of control device

Unless otherwise specified, the state of the control device shall be the state specified in 5.4. In case of the inertia proportioning valve, the state of the control device shall be such that the mounting angle is on the negative side (-3° or below).

6.2.4 Test procedure

The test procedure shall be as follows.

- (1) Fix the control device on the fitting jig. In case of a hydraulic control device, bleed air sufficiently.
- (2) Unless otherwise specified, the atmosphere temperature around the control device shall be in accordance with Table 5.

Table 5 Conditions of high temperature test

Atmosphere temperature	Use condition
70°C±5°C	Control device which can be used under normal temperature operating condition
100°C±5°C	Control device which can be used under high temperature operating condition
120°C±5°C	Control device which can be used under specially high temperature operating condition

- (3) Place the control device in a thermostatic chamber which is adjusted to the temperature mentioned above. Then, leave it as it is for three hours or more.
- (4) Depending on the type of pressure generator for which the control device is used, measure the input and output characteristics when pressure is applied under the conditions in 6.1.4.

6.2.5 Records

- (1) Input and output characteristics.
- (2) Any other noteworthy items.

6.3 Low temperature operation characteristics test procedure**6.3.1 Purpose**

This test shall be conducted to examine the operation Characteristics of the control device in low temperature atmosphere.

6.3.2 Test equipment

The devices and instruments to be used in the test shall be as follows.

- (1) **Pressure device**
The pressure device for measuring characteristics specified in 5.3 (1).
- (2) **Fitting jig**
The fitting jig specified in 5.3 (3).
- (3) **Output side load**
Unless otherwise specified, the output side load specified in 5.3 (4).
- (4) **Thermostatic chamber**
The thermostatic chamber shall be capable of maintaining the control device in low temperature atmosphere.

6.3.3 State of control device

Unless otherwise specified, the state of the control device shall be the state specified in

5.4. In case of the inertia proportioning valve, the state of the control device shall be such that the mounting angle is on the negative side (-3° or below).

6.3.4 Test procedure

The test procedure shall be as follows.

- (1) Fix the control device on the fitting jig. In case of a hydraulic control device, bleed air sufficiently.
- (2) Unless otherwise specified, the atmosphere temperature shall be $-40 \pm 2^\circ\text{C}$ for the hydraulic control device and $-30 \pm 2^\circ\text{C}$ for the pneumatic control device.
- (3) Place the control device in a thermostatic chamber which is adjusted to the temperature mentioned above. Then, leave it as it is for 24 ± 1 hours.
- (4) Depending on the type of pressure generator for which the control device is used, measure the input and output characteristics when pressure is applied under the conditions in 6.1.4.

6.3.5 Records

- (1) Input and output characteristics.
- (2) Any other noteworthy items

6.4 Airtightness test procedure**6.4.1 Purpose**

This test shall be conducted to examine the airtightness of the control device.

6.4.2 Test equipment

The devices and instruments to be used in the test shall be as follows.

- (1) **Pressure device**
The pressure device for airtightness shown in Fig. 5
- (2) **Fitting jig**
The fitting jig specified in 5.3 (3).
- (3) **Output side load**
Unless otherwise specified, the output port shall be plugged.

6.4.3 State of control device

The state of the control device shall be in accordance with either (1) or (2).

(1) Hydraulic control device

The state shall be such that the control device does not have a split point.

(2) Pneumatic control device

The state shall be such that the control device does not have a split point and shall be in accordance with 5.4.

6.4.4 Test procedure

The test procedure shall be in accordance with either (1) or (2).

(1) Hydraulic control device

- (a) Fix the control device on the fitting jig.
- (b) Maintain an air pressure of 0.1 ± 0.04 MPa for five seconds or more for input.
- (c) In the control device for two systems, test each system individually.
- (d) In the control device which detects air suspension pressure etc., confirm airtightness of the pressure chamber also. The conditions of the airtightness test shall be agreed by the parties concerned.

(2) Pneumatic control device

- (a) Fix the control device on the fitting jig.
- (b) Maintain air pressure of 0.7 ± 0.04 MPa and air pressure of 0.1 ± 0.04 MPa for five seconds or more in each case for input.
- (c) In the control device which detects air suspension pressure etc., confirm the airtightness of the pressure chamber also. The conditions of the airtightness test shall be agreed by the parties concerned.

6.4.5 Records

- (1) Presence or absence of leakage.
- (2) Any other noteworthy items.

6.5 Vacuum retention test procedure

6.5.1 Purpose

This test shall be conducted to examine the vacuum retention property of the control device as required in the hydraulic control device which is to be adapted for brake fluid vacuum filling system.

6.5.2 Test equipment

The devices and instruments to be used in the test shall be as follows.

(1) Pressure device

The pressure device for vacuum retention shown in Fig. 6.

(2) Fitting jig

The fitting jig specified in 5.3 (3).

(3) Output side load

Unless otherwise specified, the output port shall be plugged.

6.5.3 State of control device

Unless otherwise specified, the state of the control device shall be the state specified in 5.4.

6.5.4 Test procedure

The test procedure shall be as follows.

- (1) Fix the control device on the fitting jig.
- (2) Maintain a vacuum pressure of -0.1 MPa or less for five seconds or more for input.

6.5.5 Records

- (1) Presence or absence of leakage.
- (2) Any other noteworthy items.

6.6 Low temperature leakage test procedure

6.6.1 Purpose

This test shall be conducted to confirm whether or not the control device has leakage at low temperature.

6.6.2 Test equipment

The devices and instruments to be used in the test shall be as follows.

(1) Pressure device

The manual pressure device shown in Fig. 7.

(2) Fitting jig

The fitting jig specified in 5.3 (3).

(3) Output side load

The load on the output side shall be in accordance with either (a) or (b).

(a) Hydraulic control device

Unless otherwise specified, output side load shall be in accordance with 5.3. (4).

(b) Pneumatic control device

Unless otherwise specified, the output port shall be plugged.

(4) Constant-temperature and-humidity chamber

This chamber shall be capable of maintaining the control device in low temperature atmosphere.

6.6.3 State of control device

The state of the control device shall be in accordance with either (1) or (2).

(1) Hydraulic control device

Unless otherwise specified, the state of the control device shall be in accordance with 5.4.

(2) Pneumatic control device

The state of the control device shall be the state in which the control device does not have a split point and shall be in accordance with 5.4.

6.6.4 Test procedure

The test procedure shall be in accordance with either (1) or (2).

(1) Hydraulic control device

- (a) Fix the control device on the fitting jig and then bleed air sufficiently.
- (b) Leave the control device as it is in low temperature atmosphere at $-40 \pm 2^\circ\text{C}$ for 72 hours.
- (c) After 72 hours, apply fluid pressure six times at 0.7 ± 0.2 MPa and six times at 3.5 ± 0.5 MPa. Maintain the fluid pressure for five seconds at intervals of 60 seconds. Then, observe and record leakage.
- (d) When the cumulative hours for a period of which the device is left at low temperature reaches 96 hours, repeat (c).
- (e) When the cumulative hours for a period of which the device is left at low temperature reaches 120 hours, repeat (c).
- (f) In the control device which detects an air suspension pressure etc., confirm airtightness of the pressure chamber also. The conditions of the airtightness test shall be agreed by the parties concerned.

(2) Pneumatic control device

- (a) Fix the control device on the fitting jig.
- (b) Leave the control device as it is in a low temperature atmosphere at $-30 \pm 2^\circ\text{C}$ for 24 hours or more.
- (c) Increase the input pressure up to 0.7 ± 0.04 MPa and then decrease it up to the atmospheric pressure.
- (d) This process means one cycle and repeat this cycle five times at intervals of three minutes.
- (e) Observe the operation condition during the operation cycle by rise and fall in pressure gauge.

- (f) After the cycle is repeated five times, maintain the control device for five seconds or more in a state in which it does not have a split point and in a state specified in 5.4 respectively. Then, observe and record leakage.

- (g) In the control device which detects air suspension pressure etc., confirm airtightness of the pressure chamber also. The conditions of the airtightness test shall be agreed by the parties concerned.

6.6.5 Records

- (1) Presence or absence of leakage.
- (2) Any other noteworthy items.

6.7 Required fluid quantity test procedure

6.7.1 Purpose

This test shall be conducted to examine the required fluid quantity of the hydraulic control device.

6.7.2 Test equipment

The devices and instruments to be used in the test shall be as follows.

(1) Pressure device

The manual pressure device shown in Fig. 8.

The relationship between the piston stroke of the control device and the required fluid quantity is determined in advance.

(2) Fitting jig

The fitting jig specified in 5.3 (3).

(3) Piping

A short brake pipe shall be used for the piping between the control device and the cut-off valve and the required fluid quantity between them shall be minimized as far as possible. Also, the output port shall be a plug which is capable of bleeding air.

(4) Recording device

The recording device which is capable of recording the piston stroke of the control device against the fluid pressure shall be used.

6.7.3 State of control device

Unless otherwise specified, the state of the control device shall be in accordance with 5.4.

Fig. 5 Pressure device for airtightness

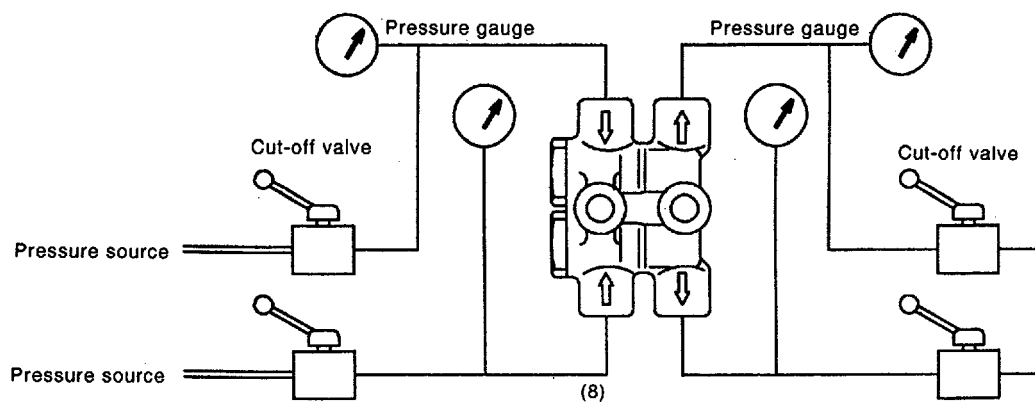


Fig. 6 Pressure device for vacuum retention

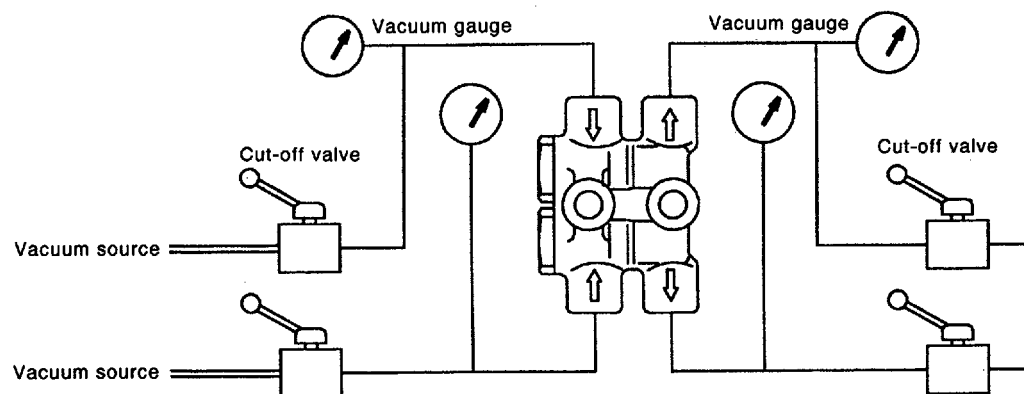


Fig. 7 Manual pressure device

