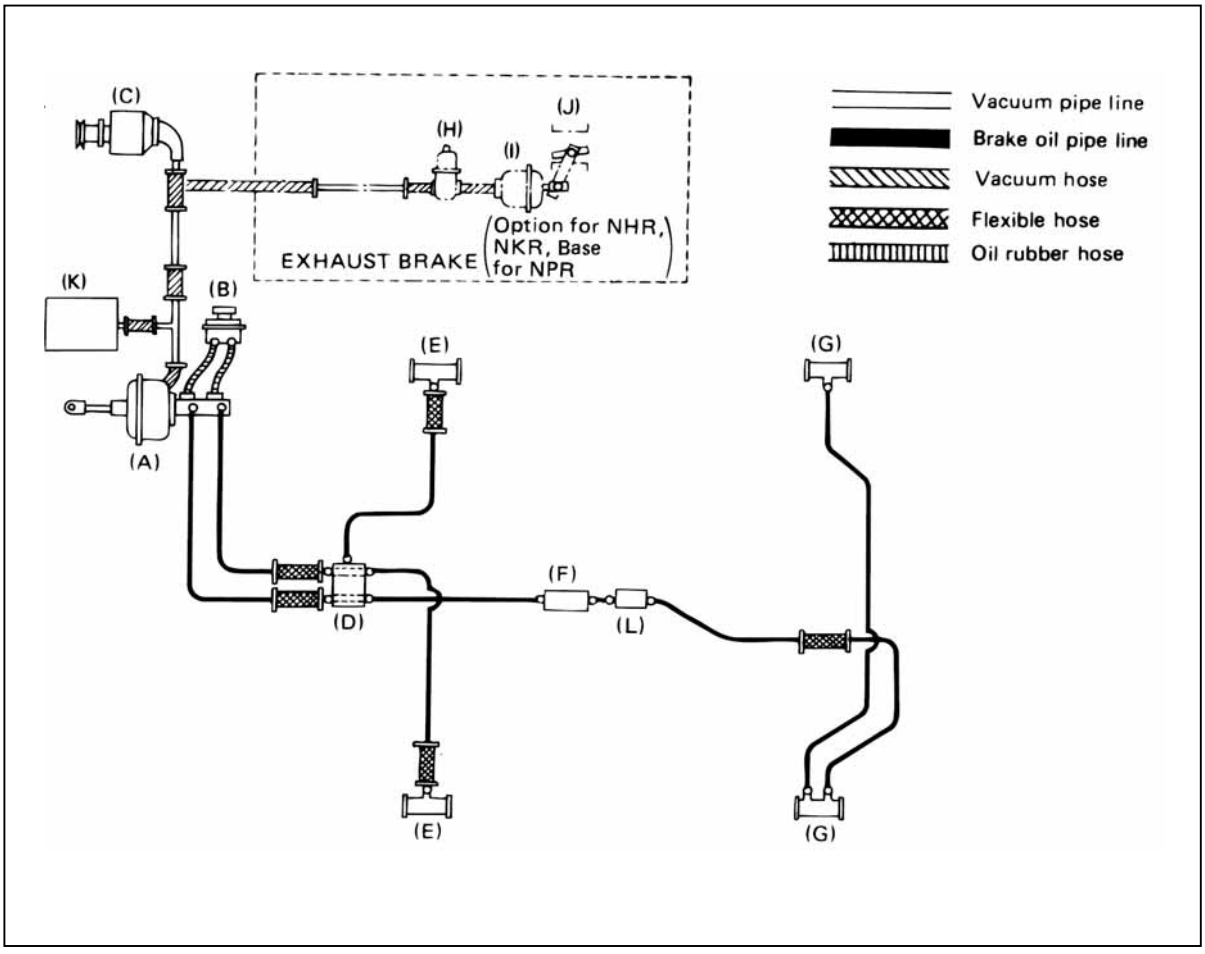
BRAKE



ISUZU

ISUZU MOTORS LIMITED

CONTENTS

SECTION 1

GENERAL DESCRIPTION

Purposes and prerequisites of installing brake

The vehicle in motion has a great deal of drive energy from the engine or from natural environmental condition such as a slope, etc., and to retard or stop the vehicle in motion against the tremendous energy, means must be provided to absorb the inertial energy.
The brake mechanism specifically designed for this purpose must satisfy the following conditions as it is a vital component having a direct influence over the road performance of the vehicle.

(1) Shorter distance to stop
- Increase in brake system capacity
- Adequate distribution of brake force
- Adoption of power-assisted brake system

(2) Stable brake action
- Improvement in anti-fade characteristics
- Prevention of one-sided brake action through adoption of automatic adjusters

(3) Excellent directional stability
- Adoption of antilock devices

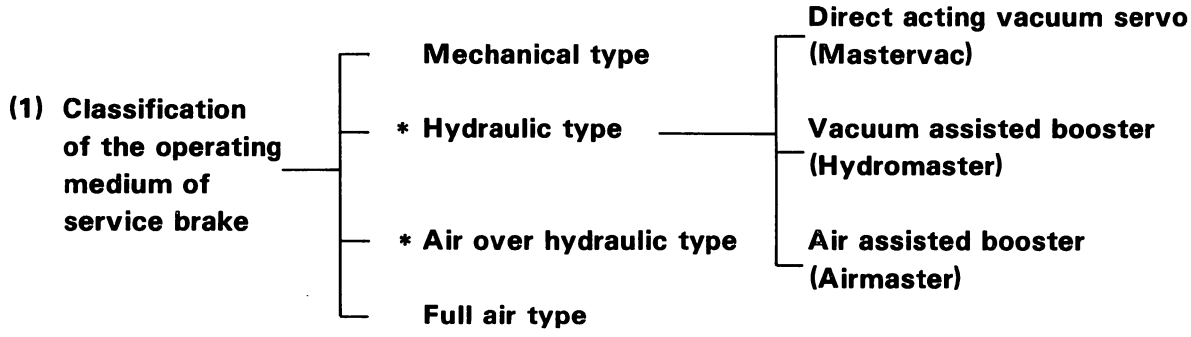
(4) Fail safe devide
- Adoption of dual-circuit brake system
- Adoption of spring brake system

(5) Minor effort for brake control
- Minimum foot pressure requirement
- Adequate setting of pedal stroke
- Appropriate pedal position

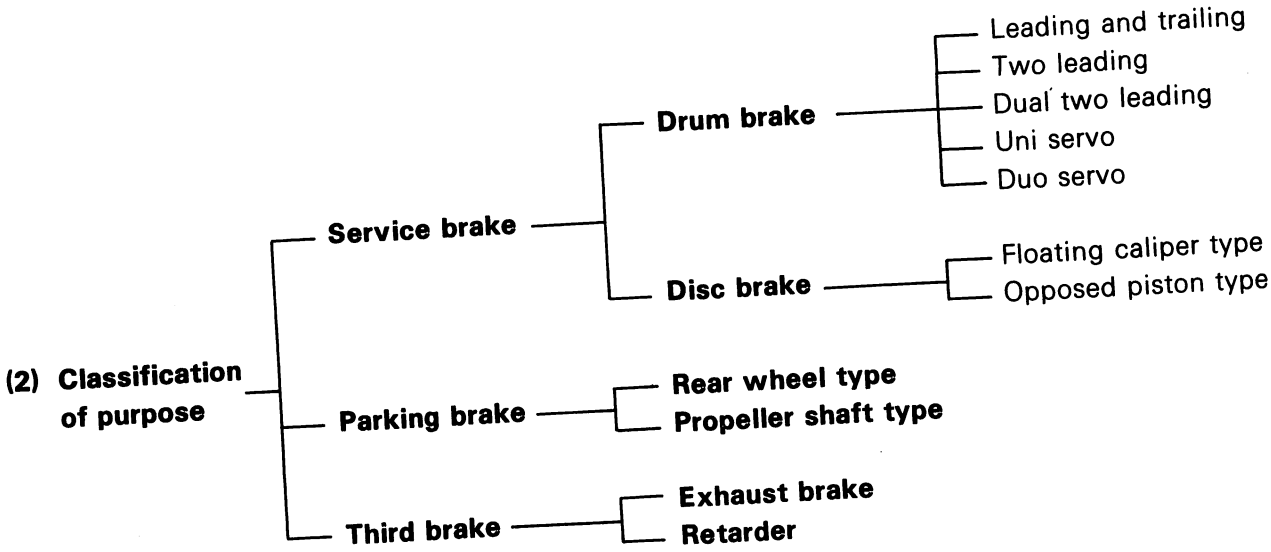
(6) Improvement in reliability and durability
- Careful selection of brake materials
- Designing with full considerations given to severe operating conditions

Classification of brakes

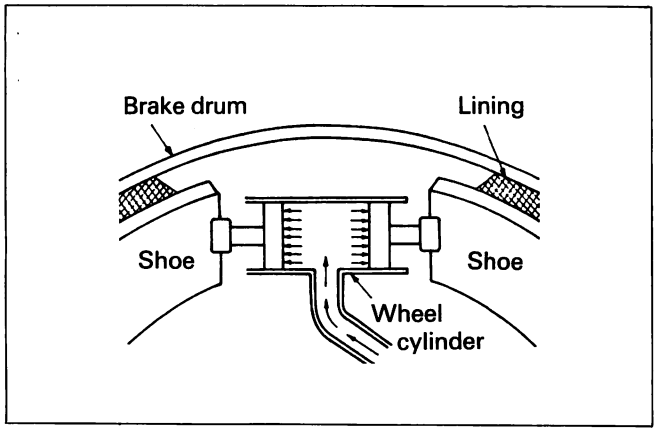
For the vehicle applications, a wide variety of brake systems have been developed which can be classified broadly into service brakes and parking brake. The service brakes adopt dual circuit system or other safety device, so that the brake system on either front or rear side will continue to provide normal brake action even when a leakage is encountered in the brake hydraulic line. The brake safety device includes antilock devices, safety cylinders, independent duel circuit and emergency brake system, etc.



Remark: Types marked * are included in this book.

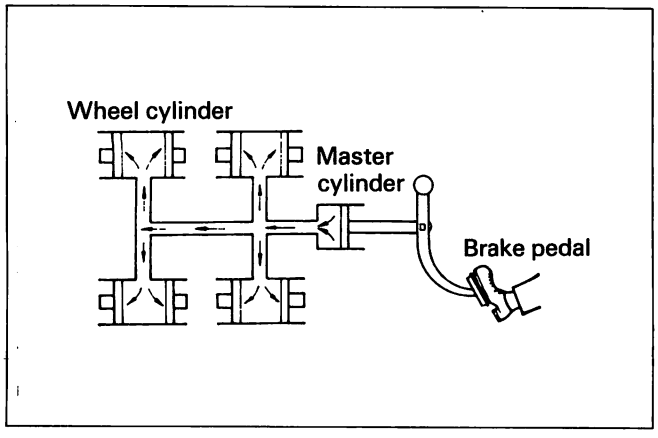

(2) Classification of purpose
Service brake
Drum brake
Leading and trailing
Two leading
Dual two leading
Uni servo
Duo servo
Disc brake
Floating caliper type
Opposed piston type
Parking brake
Rear wheel type
Propeller shaft type
Third brake
Exhaust brake
Retarder

Outline of service brake

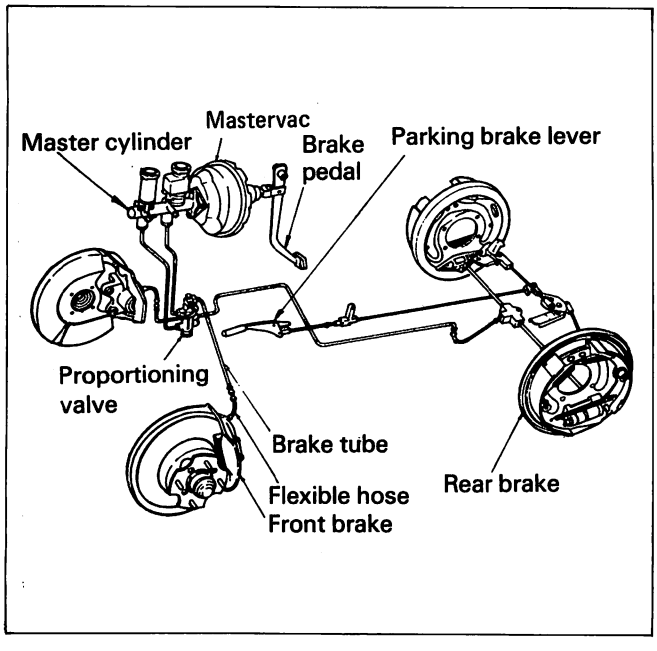


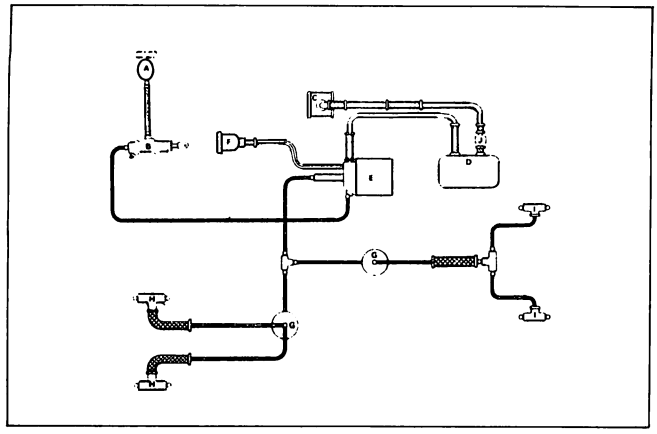
Hydraulic type

Hydraulic brake systems which employ a liquid for power transmission offer many advantage, that is, excellent response, simple construction, and a high degree of freedom in designing.
For this reason, a large percentage of the vehicles in use today employ a hydraulic brake system.
Basic system diagrams are shown at left.
The hydraulic brake consists of a master cylinder, wheel cylinders and piping parts.
When the brake pedal is stepped on, the liquid pressure is raised by the master cylinder. The wheel cylinder operates according to this pressure, and the pressure of the shoe (lining) on the drum is applied as a brake input to brake the wheel.
Because there are limits on the braking power that can be produced by stepping on the brake pedal, however, a booster is often incorporated. In addition, various control devices are employed for improving safety and brake power distribution.

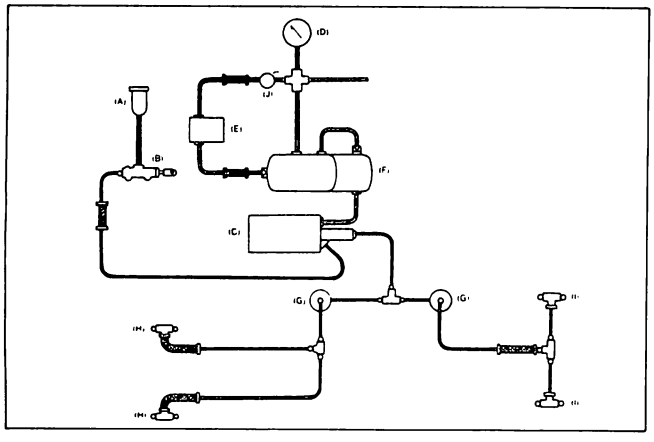


(1) Hydraulic type with Mastervac

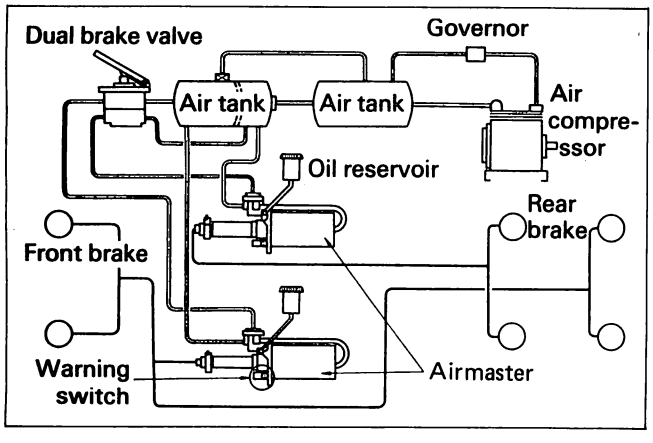


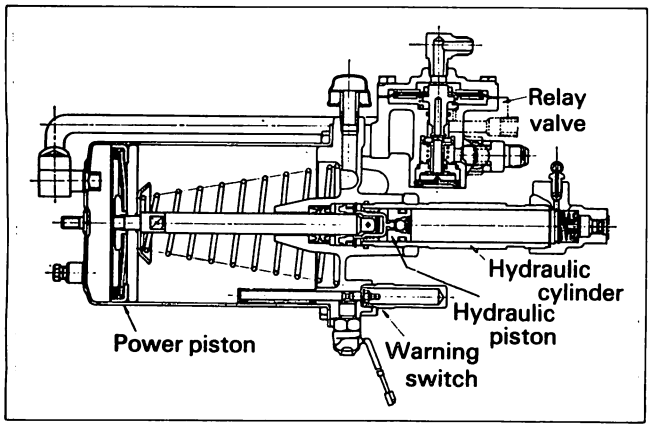


(2) Hydraulic type with Hydromaster



(3) Hydraulic type with Airmaster



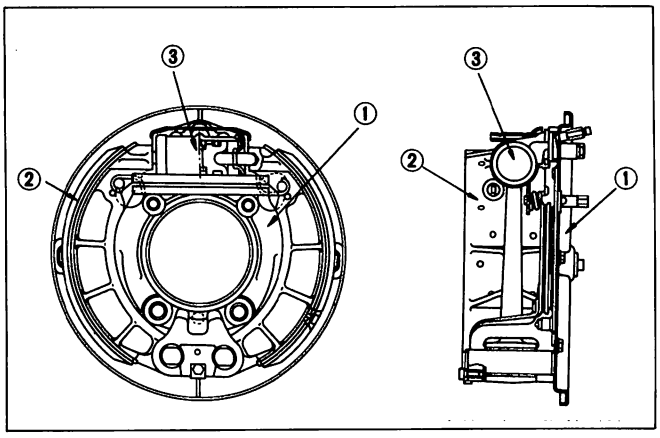


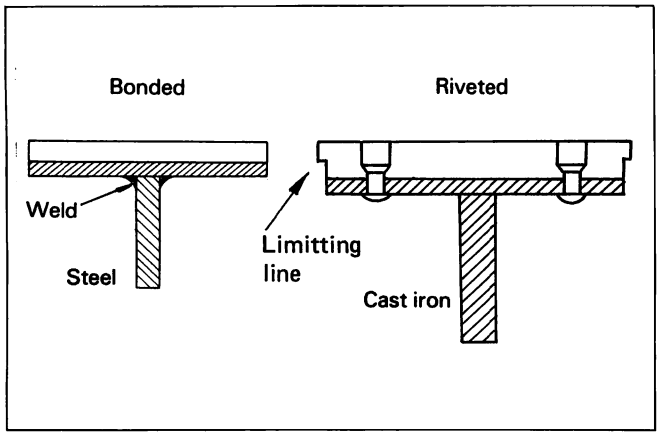
Air over hydraulic type

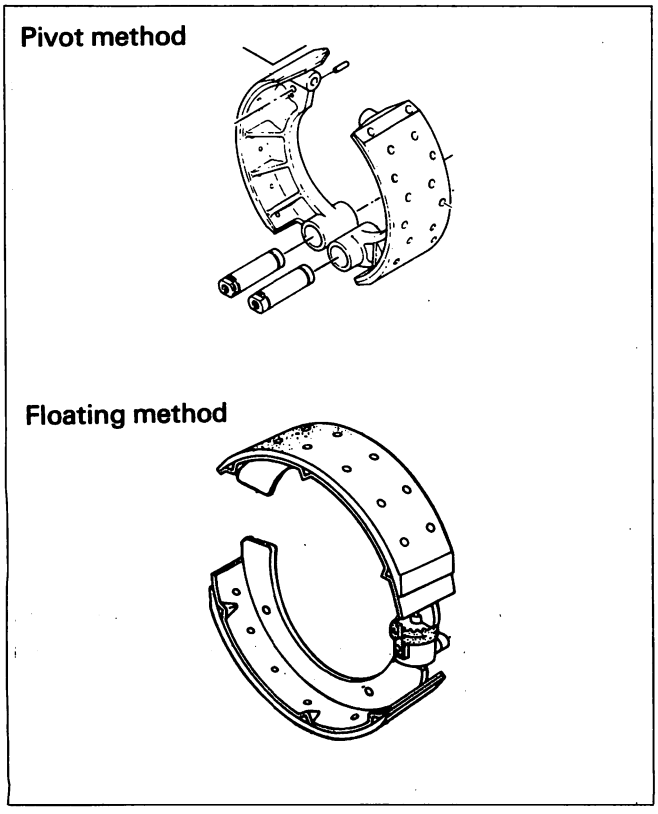
The air over hydraulic brake system features little pedal effort force, which is characteristic of a full air brakes, but a full air brake system has more braking delay. A piping example is shown at left.

This system uses a combination of brake valves, which is used in an air brake in place of the conventional master cylinder, and a pneumatic relay valve (air relay valve), which is operated by compressed air, to convert compressed air pressure to braking liquid pressure, which is sent to the wheel cylinders to brake the wheel.
Because the brake pedal needs to be depressed only to open or close the brake valve, this brake system requires merely a minimum depressing force and yet produces great braking power. Therefore, it is used for part of the heavy duty vehicles. The air booster used in this brake system is shown at left.

Construction and operation of drum brake







Construction of drum type brakes

Drum type brake of the conventional design consists basically of the back plate ① to receive brake torque, brake shoe ② and wheel cylinder ③.

Brake shoes

The brake shoe consists of a semi-circular metal piece bonded with a lining and is fitted the wheel cylinder piston at end to receive the brake force.
The brake shoe has an adequate rigidity and serves to apply brake torque to the brake drum as well as to prevent one-sided contact of the lining with the brake drum face.
The brake shoes of the conventional designs are generally in the shape of the letter "T" in cross-section and are made of steel of welded construction, steel casting, malleable cast iron, light alloy, etc.

Brake shoe anchorage

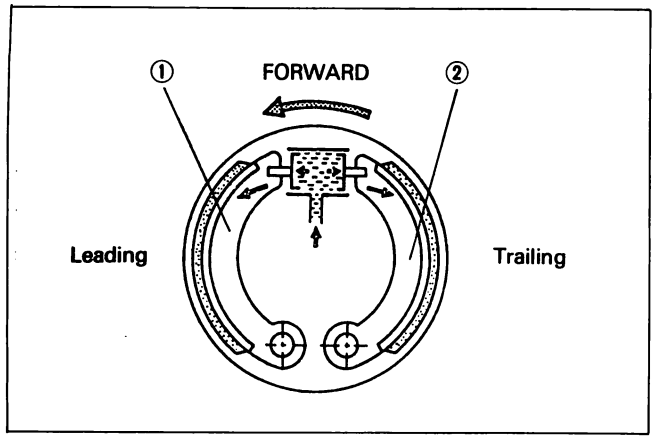
The brake shoes are generally anchored in either of the pivot or floating method.

(1) Pivot method

The brake shoe is fitted at one end to the anchor pin such a way that it is made to pivot within a limited angle.
When the brake shoe is pivot anchored, a alignment is obtained between the shoe and brake drum, but one-sided contact is liable to occur unless the lining surface is accurately finished.

(2) Floating method

The shoe has a curved end which is fitted against flat face of the anchor, so that a sliding action is permitted between the contacting faces to follow the curvature of the brake drum face.
However, this advantage is offset to a certain extent, as the anchoring position of the brake shoe is unsteady, brake dragging tends to occur, unless the force of the springs is carefully balanced.



Types of brake shoes

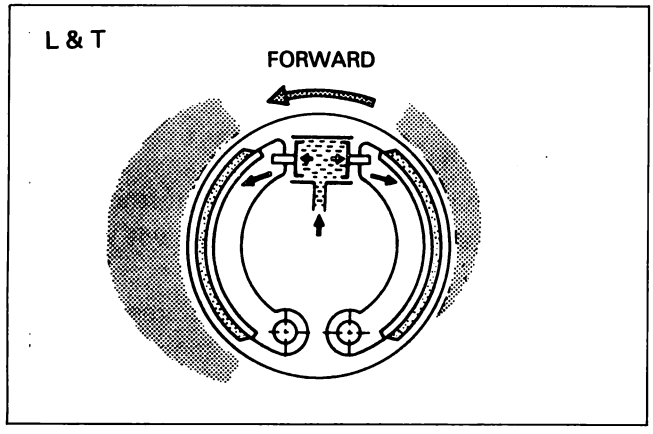
The drum type brakes are generally classified according to the type of the brake shoes employed. However, they can be classified further into the following distinct groups according to the direction of action and brake shoe combination.

(1) Leading shoes

The leading shoe is fitted against the wheel cylinder at one side (input side) ① and anchored at another end furthest from the wheel cylinder in the direction of the wheel rotation.

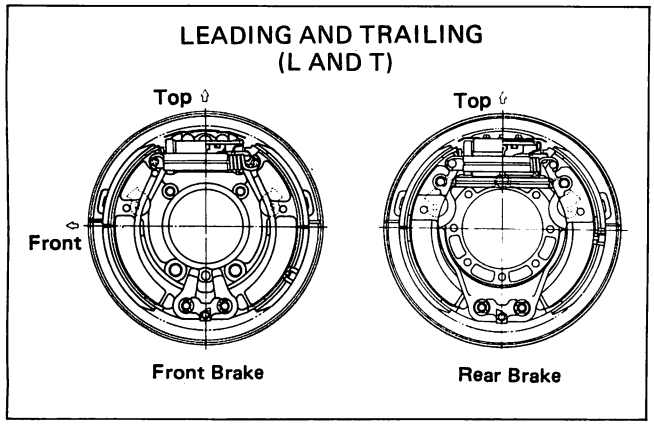
(2) Trailing shoe

The trailing shoe is anchored in reverse direction with the input side ② positioned in reverse direction of wheel rotation.
The leading shoe tends to become wedged between the brake drum by the self servo action, however, trailing shoe provides weaker brake action as effect of self energization acts negatively on the trailing shoe.



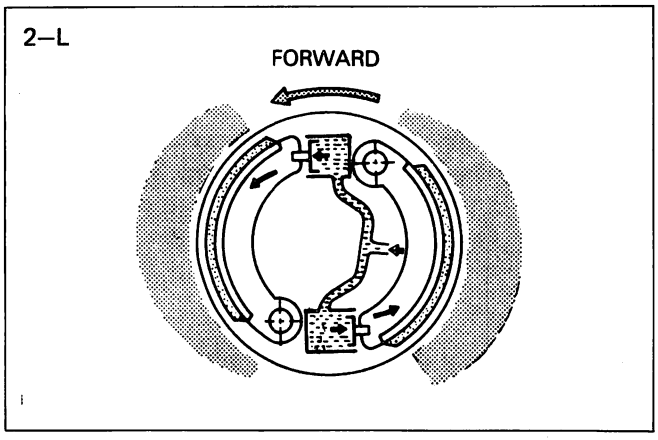
Leading and trailing type

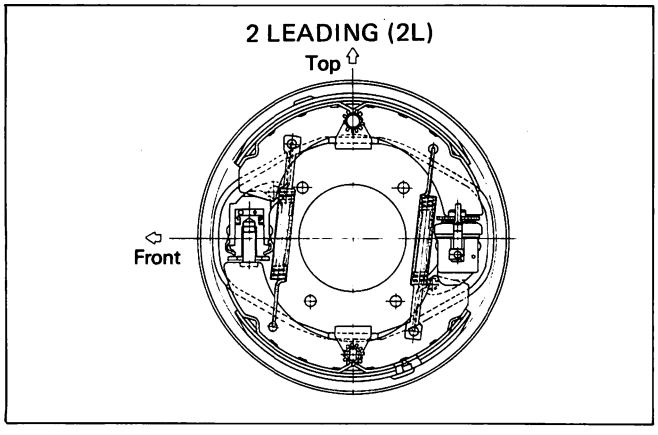
The leading and trailing type brake has the combination of leading and trailing type brake shoes and this type of brake is called non servo because of very limited servo action.
The leading and trailing type uses a single wheel cylinder and provides a moderate brake action but features a stable brake action.
The same rate of brake action is obtained when braking while in forward or reverse motion, provided both the leading and trailing shoes have the same contact pressure.

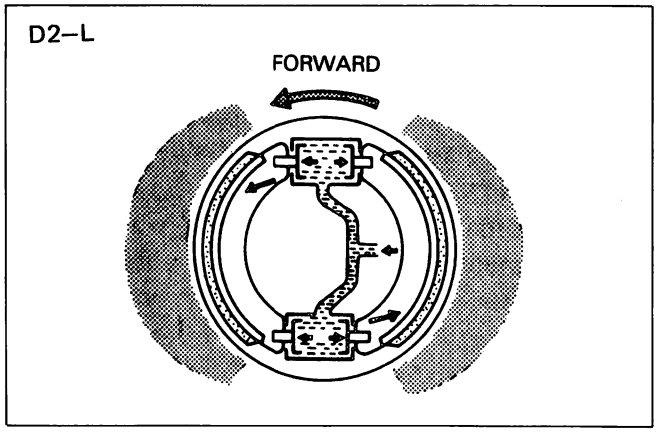


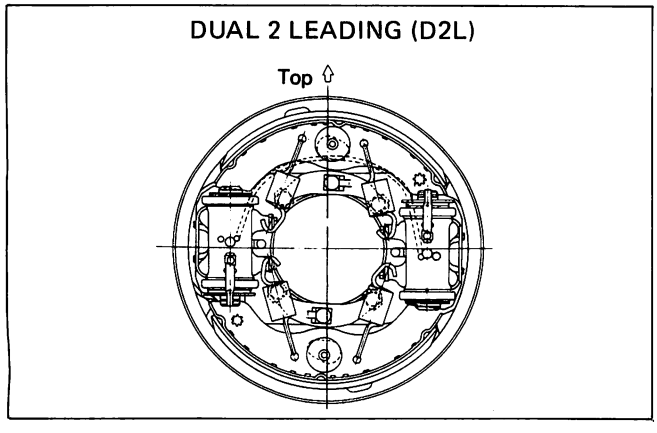
Advantages:
Rigid and simple in construction and provides dependable brake action.
Nearly equal brake action is provided in both forward and reverse stops.

Disadvantages:
Brake force is somewhat weaker when compared with other type brakes of the same drum diameter and total lining area.









Two leading type

The two leading shoe type brake has the combination of two leading shoes.
As the leading shoes provide nearly equal brake force, prevents uneven distribution of load on the hub bearings, this type of brakes are widely used on the front wheels of passenger car and the front and the rear wheels of light-duty trucks.

Advantage:
Similar to leading-Training type brake system in construction and brake action but two leading shoes combine to deliver greater braking force on forward stops

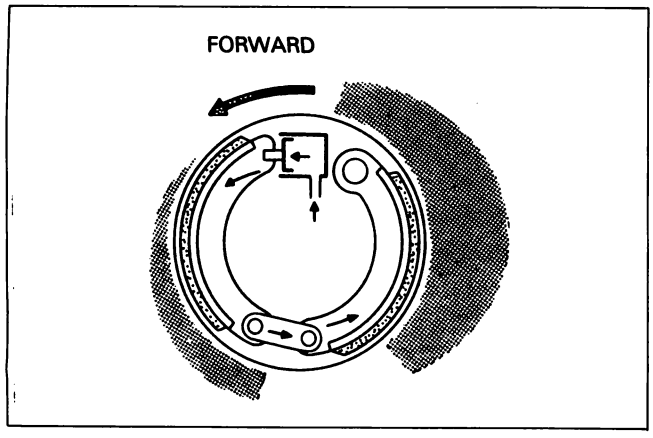
Disadvantages:
On reverse stops, both of the shoes act as trailing shoes and deliver a brake force almost one third that obtained forward stops.
Use of two wheel cylinders causes an increase in manufacturing cost.

Dual two-leading type

This type is intended to cover the weakness of two-leading shoe type which delivers weaker brake force on reverse stops, with the advantage of two leading shoe type brake intact.
This type uses a pair of double acting wheel cylinders, so that both the brake shoe are made to work as leading shoes in either forward or reverse motion. Distribution ratio of brake force over the front and rear wheels is generally determined as 7 to 3 for passenger cars and 4 to 6 for trucks on account the load they are made carry.
In general, trucks have two-leading type brakes on the front and dual two-leading type on the rear as the rear wheels of a truck are required to have greater brake force both in forward and reverse stops.

Advantages:
Improved in design to provide higher brake force when reversing with the advantages of the two-leading shoe type brake held intact.

Disadvantage:
An increase in cost is unavoidable as a pair of double-action wheel cylinders are used.
Both the wheel cylinders become inoperative even when a leakage develops in a cylinder due to worn piston cup.



Uni servo type

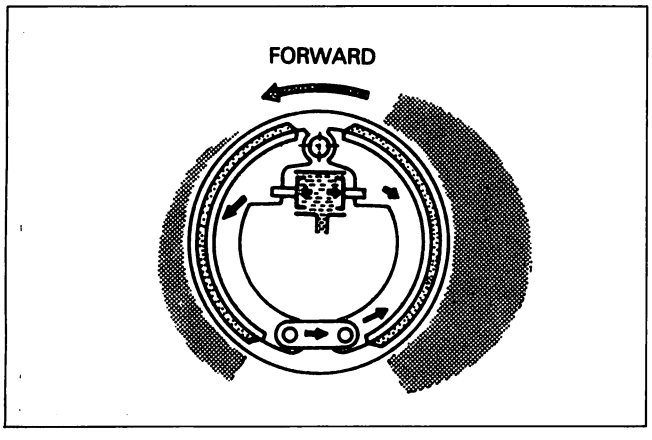
This type has a wheel cylinder with a single piston to provide a due servo action only in forward motion, allowing the shoes to act as trailing shoes on reversing. The uni servo type brakes are not normally used for their limited brake action in reverse stops.

Advantages:

The uni servo brake utilizes for actuating the secondary shoe the expanding force energized through the action of the primary shoe so that the secondary shoe provides a high braking force. Such a characteristic is disirable to obtain maximum brake force from the limited drum diameter and lining area.

Disadvantages:

Multiplied braking force of the servo brakes promotes tendency of the wheels to lock, causing a slight variation in time taken for the wheels to lock to make the vehicle spin or skid. When the vehicle is reversing, the brake force declines as low as 1/6 of that provided with the vehicle in forward motion.



Duo servo type

The duo servo type has the leading shoes anchored at a single point and fastened together by means of a link.

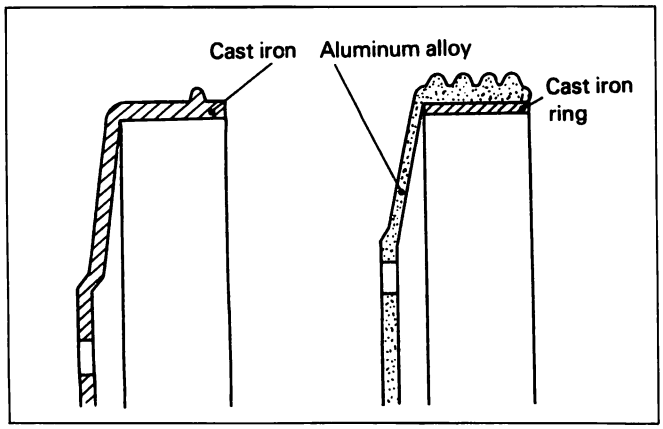
The shoes on the input and anchored sides are called primary shoe and secondary shoe, respectively.

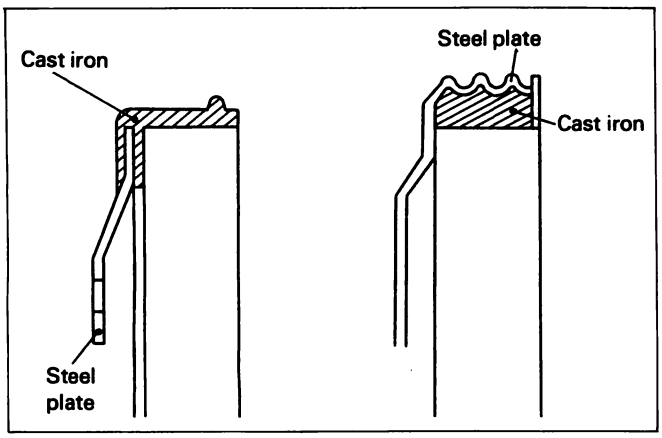
Advantages:

As the brake output developed in the primary shoe is carried by the link to secondary shoe, a great brake force is obtained even when a minor force is developed in the primary shoe. Similar brake force is provided even when reversing.

Disadvantages:

This design promotes tendency of wheel locking. As a tremendous brake force is provided, even a minor difference of time taken before the wheels become locked causes a side slip to occur.





Brake drums

In general, the brake drums are made of iron casting which is high in friction coefficient and wear resistance. Various types of brake drums have been developped to reduce weight and to improve cooling efficiency.

(1) Cast iron brake drums

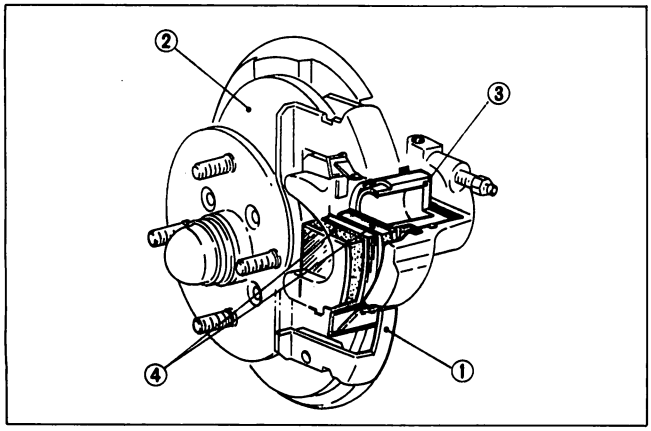
(2) Aluminum alloy + iron casting

The drum body is made of aluminum alloy to reduce weight. The outer face is provided with fins to improve cooling and cast iron is cast into aluminum body to provide a friction face.

(3) Steel plate + iron casting

The drum body is pressed with steel plate and cast iron is cast into the body.

Disc brake



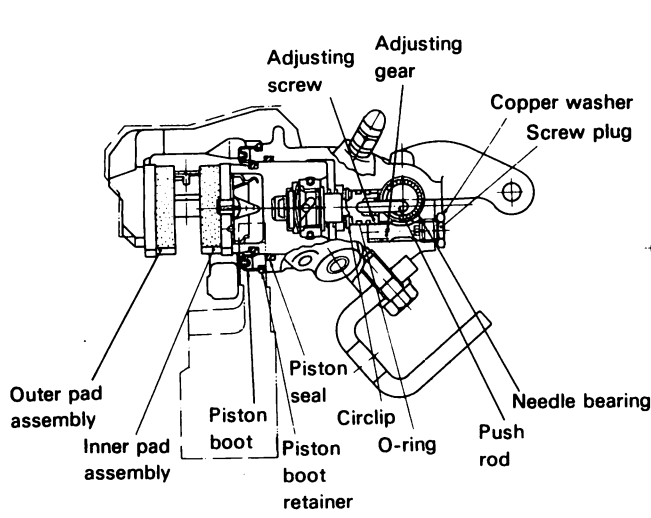
Construction of disc type brakes

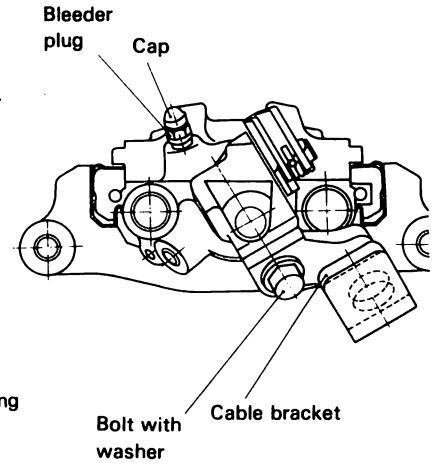
The disc brake consists basically of the caliper ①, disc ②, piston ③ and pad ④, and disc pads are forced against the friction faces of the disc to provide a brake force.

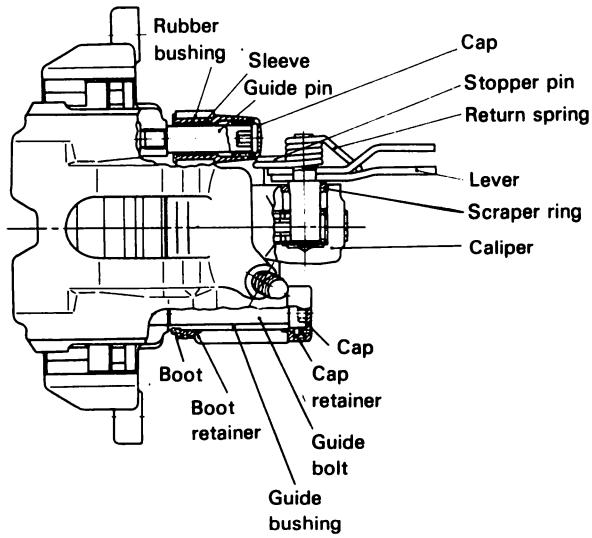
The brakes are required to provide a strong and stable brake force. Effective and stable brake action is important particularly for high performance passenger cars and disc brakes have been developed to satisfy the requirement.

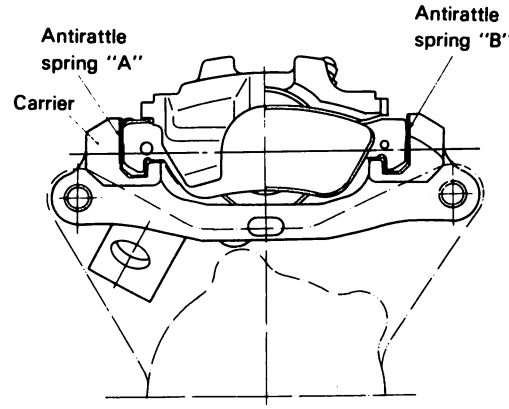
Disc brakes are commonly used in combination with a servo system to provide an effective brake action as they are smaller than drum type brakes in total friction area.

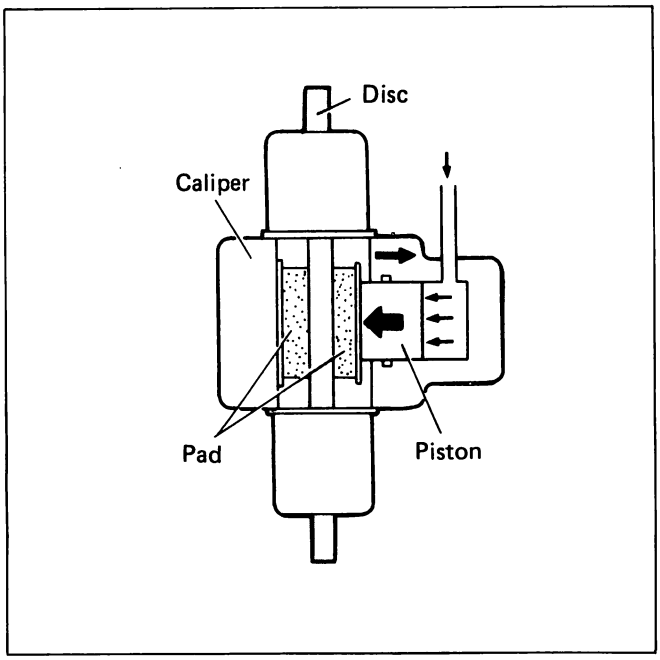
DISC BRAKE DRAWING (for UBS Rear)







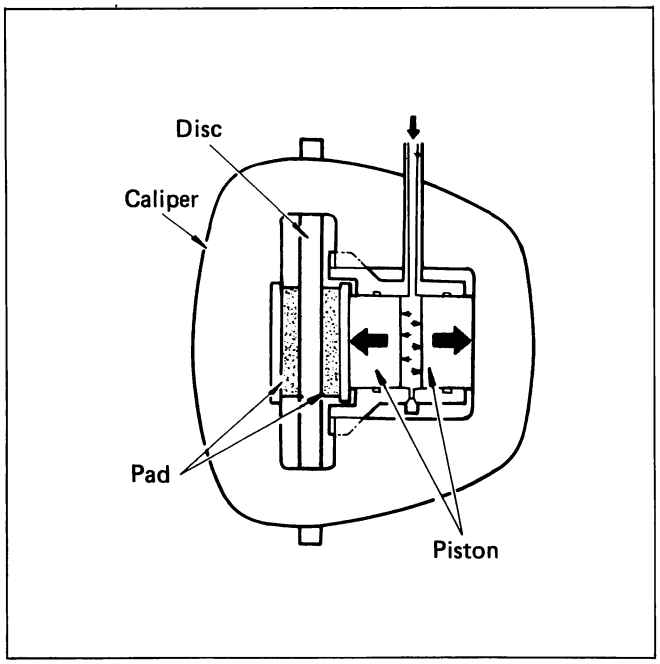




TYPES OF DISC BRAKES

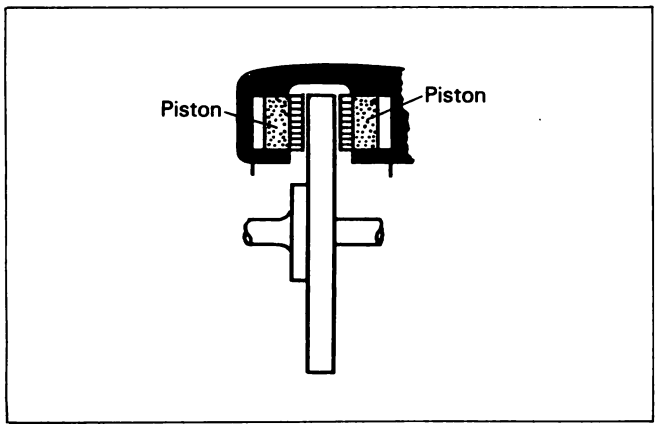
Floating caliper type (Single piston type)

A single piston is fitted into one side of the caliper which floatingly supported.
As the brake fluid within the master cylinder is pressrized, the piston forces the pad against the disc, and repulsive force of the fluid causes the pad on the opposite side to work against the disc to provide a brake action.
This design has an advantage that a kick back form the disc in take up as the movement of the caliper causing no insrease in the piston stroke.



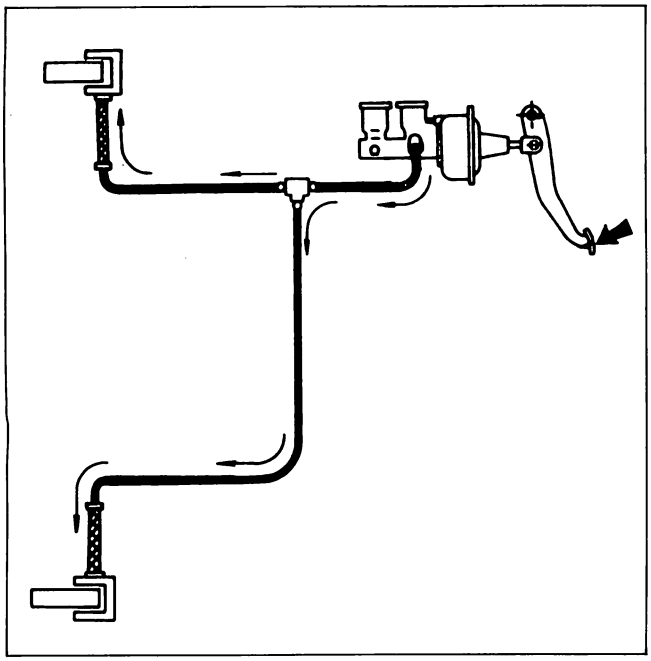
Floating caliper type (Double piston type)

This type also has a single cylinder but a pair of pistons that are fitted back to back into the cylinder. One of the pistons acts directly on the brake pad while the other piston is made to push the brake pad against the disc via the caliper.



Opposed piston type (Double piston type)

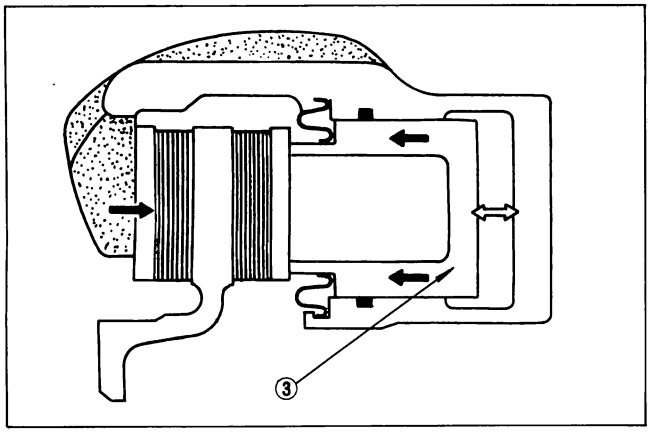
This type has a piston on each side of the caliper which is fixedly mounted.
As the brake fluid in the master cylinder is pressurized, both the pistons force the pads against the disc to provide a brake action.
This type can be made sturdy in construction because of absence of sliding parts with the exception of pistons.
However, kick back from the disk is liable to be carried to the brake control as the caliper is fixedly mounted.



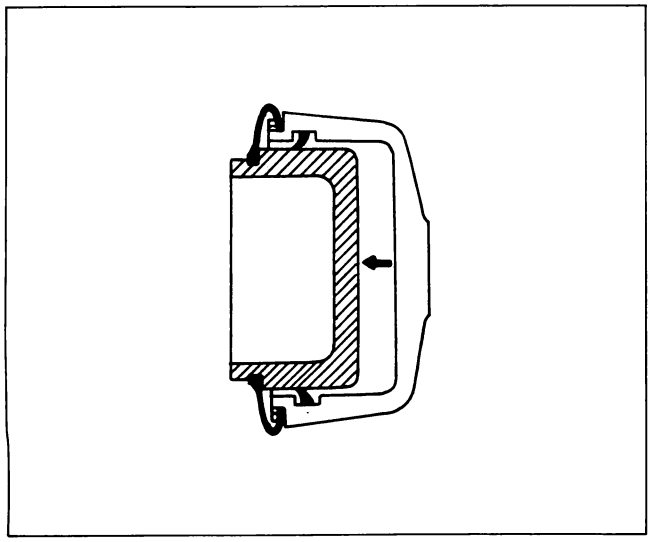
Operation

1. When brake pedal is depressed

When the brake pedal is depressed, the piston in the master cylinder is operated and pressurized brake fluid fed, via the brake pipes, into the cylinder in the disc brakes.



As the pressure of brake fluid increases, the piston ③ is forced outward to provide a brake action.



****AUTOMATIC BRAKE ADJUSTER***

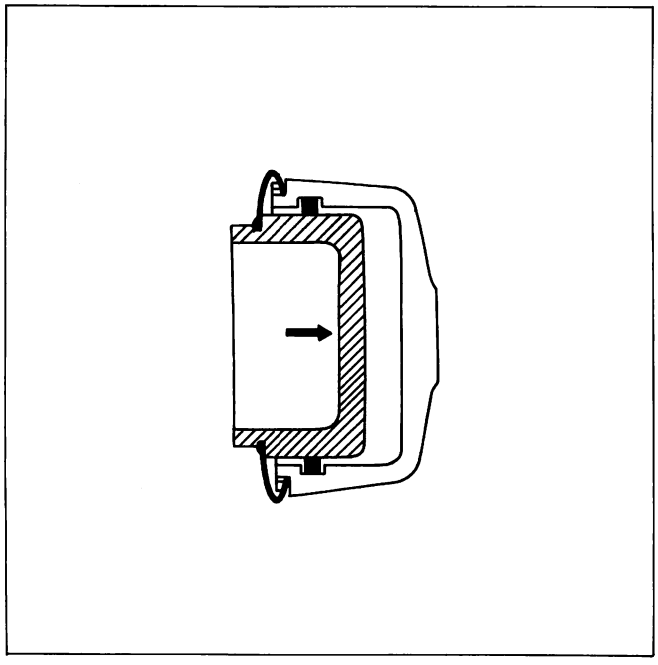
Since the cylinder in the disc brake system is larger than wheel cylinder of the drum type brakes in cubic capacity, the hydraulic circuit will be cleared of a residual pressure **when the brake pedal is released.**

The disc brake system is so designed that the brake pads are sufficiently retracted to maintain a slight clearance between the pads and disc, and if this clearance is excessive, the brake pedal effective stroke increases and in an extreme case, bottoming of brake pedal may result.

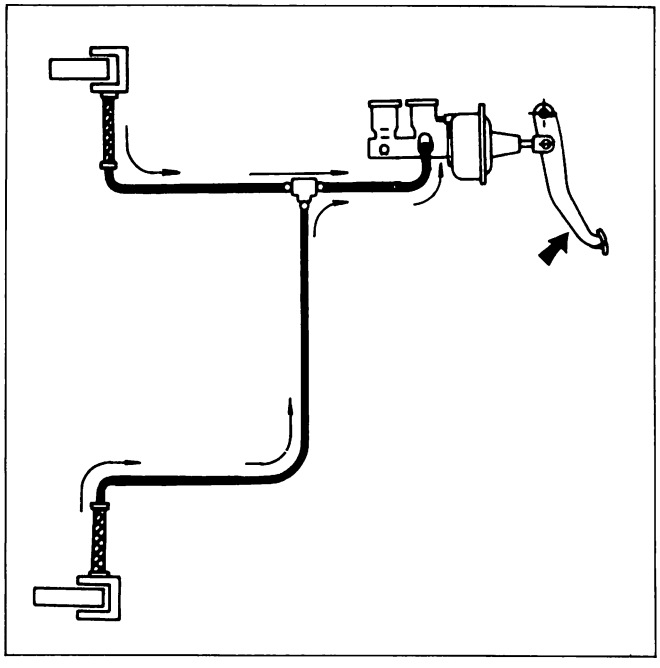
And, to prevent this, the disc brake system is provided with an automatic adjuster.

By the action of the automatic adjuster, the clearance between the disc and pad(s) is adjusted by flexing of piston seal.

As wear in brake pad(s) advances, the piston slides forward over the piston seal and piston seal is further distorted each time the brake pedal is depressed.



As the fluid pressure diminishes, the piston is returned to original position by the recovery action of elastic piston seal.



2. When brake pedal is released

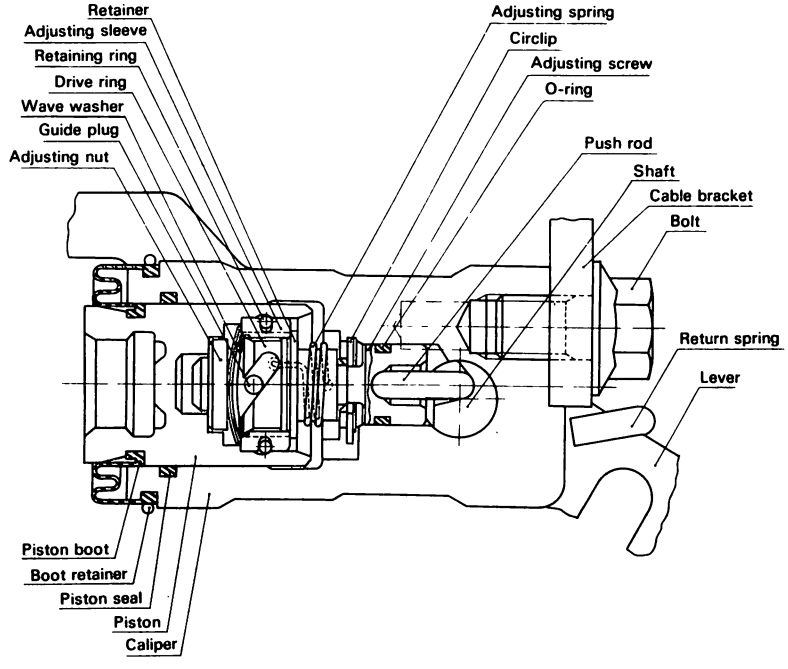
When the brake pedal is released, brake fluid flows back into the master cylinder form the cylinder in the disc brakes, so that piston is returned to the original position by the recovery action of the elastic piston seal.

Automatic adjusting device for UBS rear disc brake

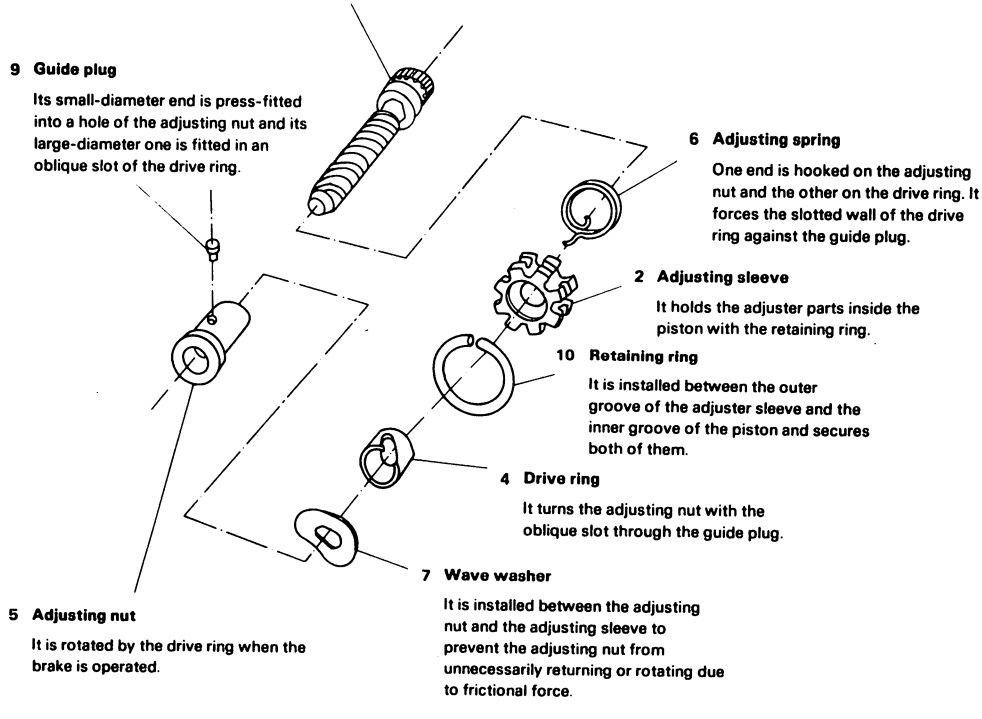
(1) General description

When the parking brake lever is operated, the brake pads are mechanically pressed against the brake disc rotor.

This brake system is equipped with an automatic adjuster which maintains the clearance between the disc rotor and brake pad constant through the operation of the foot brake system. The automatic adjuster consists of an adjusting screw, an adjusting nut, a wave washer, a drive ring, an adjuster spring, etc. as shown in the figure below.



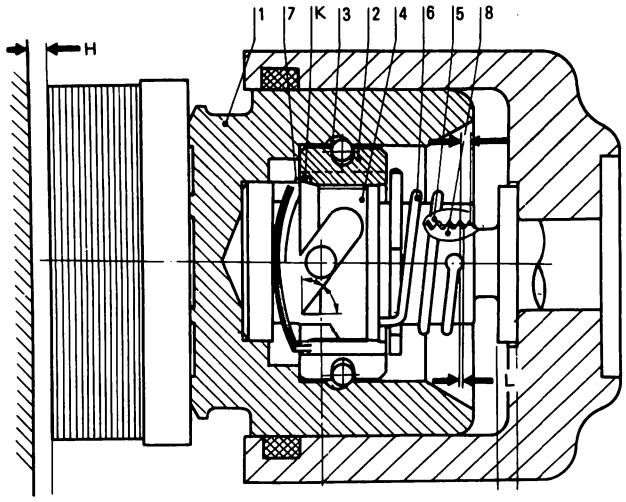
(2) Component parts



(3) Operation

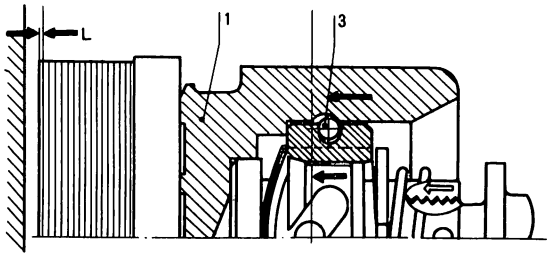
Step 1

Due to the seal's roll-back action, the thread face of the screw (8) is in contact with that of the nut (5). The nut is pressed in the axial direction by the force of the wave washer (7). The drive ring (4), under the twisting torque of adjusting spring (6), is in a frictional contact with the grooved sleeve (2) at the conical surface (K). The axial play of the screw (8) is caused only by the thread backlash (L).



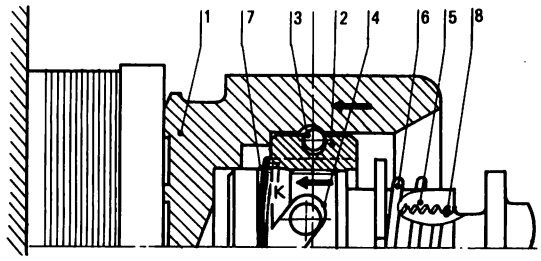
Step 2

When the fluid pressure is applied, the piston (1) moves toward the disc. By this movement, the adjuster parts (screw (8), etc.) are moved as a whole forward along with the piston (1), by an amount equivalent to the thread backlash.



Step 3

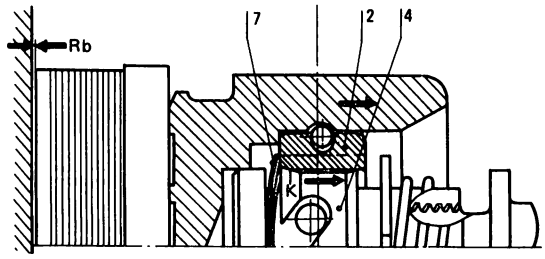
When the piston (1) strokes more than the backlash amount, the nut (5) separates from the piston due to deflection of the wave washer (7). Then, the grooved sleeve (2) and the drive ring (4) are forcibly moved forward through the ring (3). The drive ring's oblique slot overcomes the friction torque of the wave washer and turns the nut (5) in proportion to the piston stroke. At this point, the driving ring (4) does not rotate together with the grooved sleeve (2) due to the friction on the conical surface (K). Besides, the set load of the coil spring (6) is increased by the rotation of the nut (5).



Step 4

Release of fluid pressure

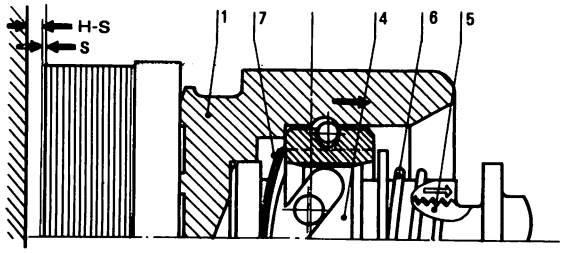
Due to the seal's roll-back action and by the force of the wave washer (7), the piston returns back by an amount equal to Rb from the disc. During this step, the friction torque at the conical surface (K) decreases.



Step 5

The piston (1) is returned by the wave washer (7) until it comes into contact with the end surface of the nut (5). During this operation, the preloaded coil spring (6) turns the drive ring (4) by an amount equivalent to the friction (S).

The relative position of the nut (5) and the drive ring (4) is always set to the point at the beginning of the adjustment.



Brake fluid

1. Kind of brake fluids

1 Water-soluble brake fluid
2 Hydroxide brake fluid
3 Ethylalcohol or butyle alcohole brake fluid
4 Diacetone alcohol brake fluid
5 Ethylene glycol brake fluid
6 Mineral oil brake fluid

Many kinds of brake fluids such as mentioned above are used. To put it simply, brake fluid is a mixture of alcohol and a vegetable oil, such as castor oil.

2. Brake fluid requirements

Brake fluid must meet the following requirements.

1 Good corrosion resistance
2 Free from change in nature for a long time
3 High boiling point
4 Satisfactory lubrication

3. Precautions about brake fluid

Be sure to use the brake fluid specified for the vehile. If different brands are mixed, the boiling point inevitably falls so that vapor lock tends to occur.
Isuzu now uses a brake fluid called HG Super 2300.

Features of HG Super 2300

- HG Super 2300 is made mainly of glycol and glycol ether , and has a high boiling point of 225°C.
- It has improved corrosion resistance because it uses a new special rust preventive chemical and additives: and also offers excellent resistance to metal corrosion and rubber expansion.
- It satisfies today's highest standard of SAEJ17036.

Comparison of Properties

Test item \ Brand name	BESCO HG Super 2300	BESCO HG Super 2000	SAEJ17036
Boiling point	224.5°C	204°C	190°C or over
Flash point	112.7°C	99°C	82°C or over
Viscosity –40°C	1343 cst	1215 cst	1800 cst or less
50°C	8.31 cst	8.3 cst	4.2 cst or more
100°C	3.12 cst	3.1 cst	1.5 cst or more
Rubber expansion (SBR)			
70°C x 120 hr hardness change (Hs)	3	9	10 or less
Cup base diameter change (Diameter 1-1/8 inches)	0.39 mm	0.52 mm	0.15 to 1.4 mm
120°C x 70 hr hardness change (Hs)	4	10	15 or less
Cup base diameter change (Diameter 1-1/8 inches)	0.45 mm	0.96 mm	0.15 to 1.4 mm

Precautions about use of HG Super 2300

1 The brake fluid is colorless and clear, and turns light yellow during use, but this does not adversely affect performance.
(HG Super 2000 is orange in color.)

2 HG Super 2300 may be mixed with HG Super 2000 without problems for practical purposes, but never mix HG Super 2300 with any other brake fluid because it can adversly affect performance.

SECTION 2

MAIN DATA AND PIPING DIAGRAM

HYDRAULIC BRAKE SYSTEM APPLICATION CHART
(Passenger car, pickup & wagon)

Front disc, Rear leading trailing drum with mechanical operate parking.

Model	Type	Piping Diagram	Master Cylinder Dia. (mm)	Servo Cylinder Dia. (mm)	Front Brake Disc. Effective Dia. (mm)	Rear Brake Drum Dia. (mm)
JT series	Dual circuit split diagonal Vacuum assisted tandem master.	H1, H2	20.64	180	182	L & T 180
JJ series		H3	22.2	205	188	L & T 203.2
TF series	Dual circuit split front and rear, Vacuum assisted tandem master.	H5		205	203	254
UBS series		H6	23.81	230		

Front disc and rear disc with mechanical operate parking.

Model	Type	Piping Diagram	Master Cylinder Dia. (mm)	Servo Cylinder Dia. (mm)	Front Brake Disc. Effective Dia. (mm)	Rear Brake Disc Effective Dia. (mm)
JR (RHD) series	Dual circuit split front and rear, Vacuum assisted tandem master	H4	22.2	205	188	192
UBS17, UBS55	Dual circuit split front and rear, Vacuum assisted tandem master	H7	25.4	205 Tandem	203	223

Front, rear disc for service brake and duo servo drum for parking.

Model	Type	Piping Diagram	Master Cylinder Dia. (mm)	Servo Cylinder Dia. (mm)	Front Brake Disc. Effective Dia. (mm)	Rear Brake Disc Effective Dia. (mm)	Rear Drum Dia. (mm)
JR (LHD) series	Dual circuit split front and rear, Vacuum assisted tandem master	H4	22.2	205	213	229	170

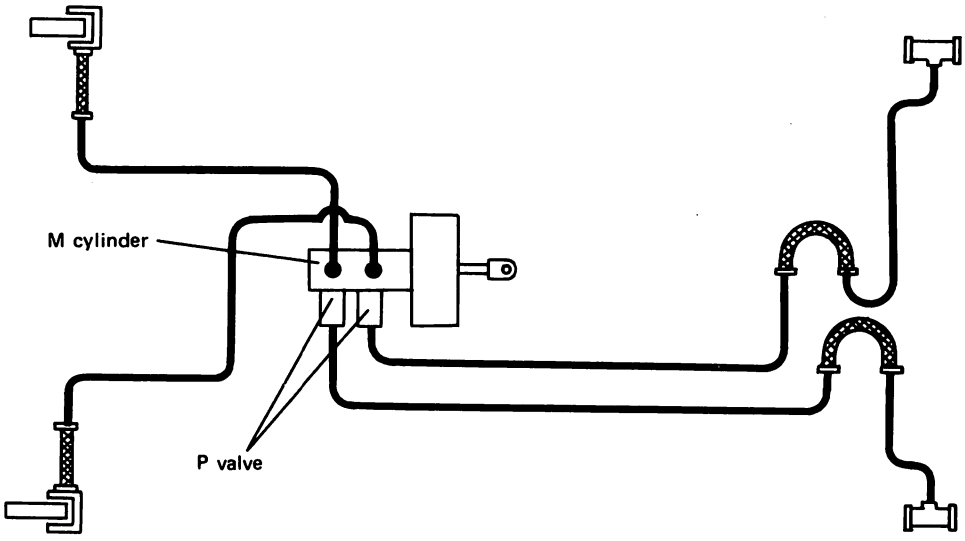
HYDRAULIC BRAKE SYSTEM

Model	Type	Piping Diagram	Master Cylinder Dia. (mm)	Servo Cylinder Dia. (mm)	Wheel Brake Type	Front Brake Disc/Drum Effective Dia. /Width (mm)	Rear Brake Drum Effective Dia. /Width (mm)
WFR	Dual circuit vacuum assisted tandem master	H—8	22.2	205.0	front disc and rear drum with wheel parking (L & T)	202	254/50
WHR	Dual circuit vacuum assisted tandem master	H—9	25.4	190.5	Drum F; 2L, R; D2L	300/55	279.4/60
NHR				205.0		279.4/60	
NKR (S)		H—10	26.99	230	Drum F; 2L R; D2L	300/55	300/55
NKR (D)						300/75	300/75
NPR57, NKR58			28.57	266.7			
NPR59						320/75	320/75
BL, BE (RHD)		H—11	25.4	190.5		300/75	300/75
BE (LHD)				228.6			
FSR-1B, MR1-1B	Single circuit with safety cylinder vacuum servo	H—12	38.1	241.3	Drum F; 2L R; D2L	320/110	320/120
FSR-R-1B						400/115	410/115
HTR, HTS							400/130
HTW		H—13	44.5				400/115
HTR-4B, HTS-4B	Single circuit with safety cylinder air servo	H—14	44.5	114.3	F; 2L, R; D2L	400/115	400/130
HTR-X-4B					F & R; L & T		400/140
HTW-4B		H—15			F; 2L, R; D2L		400/115
DVR-4B, C-R		H—14		138	F & R; L & T	410/140	410/180

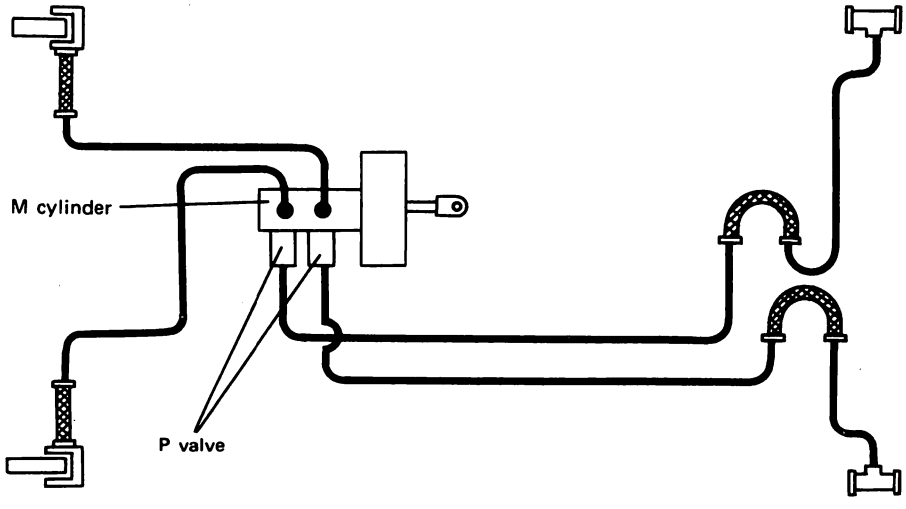
DUAL CIRCUIT AIR OVER HYDRAULIC BRAKE SYSTEM

Model	Brake Control		Piping Diagram	Hydraulic Cylinder Dia. (mm) F/R	Air Cylinder Dia. (mm) F/R	Air Tank Capacity (L)	Brake Drum Dia. (mm)	
	Front	Rear					Front	Rear (FR/RR)
DXZ-2B CXZ-16 CXM-16	Direct	Direct	AO-1	29.1/29.1	138/138	20 + 15 + 20	L & T 410	L & T 410/410
CVR-16		w/Relay valve	AO-2			30 + 15 + 20	L & T 410	L & T 410
FSR-16, MR1-16		Direct	AO-3	23.8/23.8	114.3/114.3	7 + 7 + 7	2L 320	D2L 320
FSR-R, FSS, FTS							2L 400	D2L 410
FTR-16, FVR-16			AO-4	29.1/29.1	138/138	23 + 11.5 + 11.5	L & T 410	L & T 410
LT1						20 + 13 + 13		
MT1						20 + 17 + 17		
(OPTION) WHEEL PARK	Direct	Direct	AO-5					

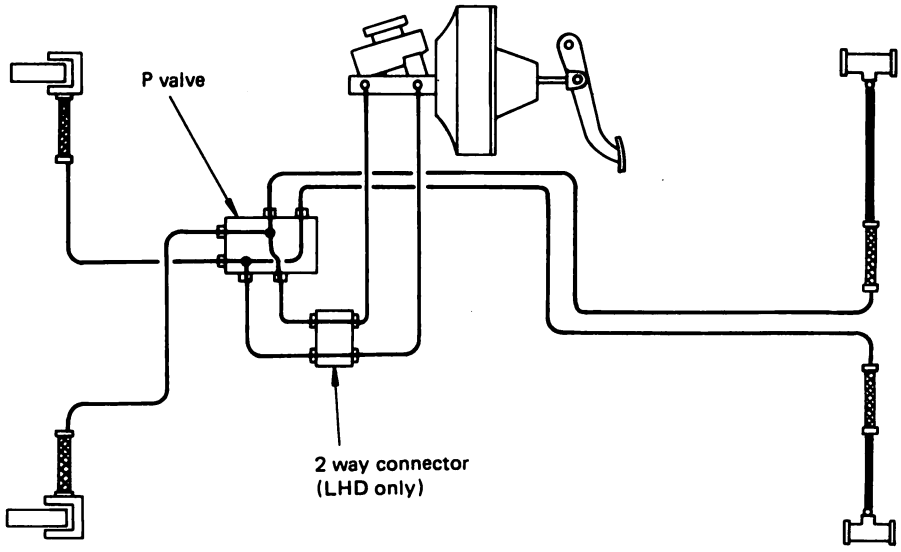
JT RHD H-1



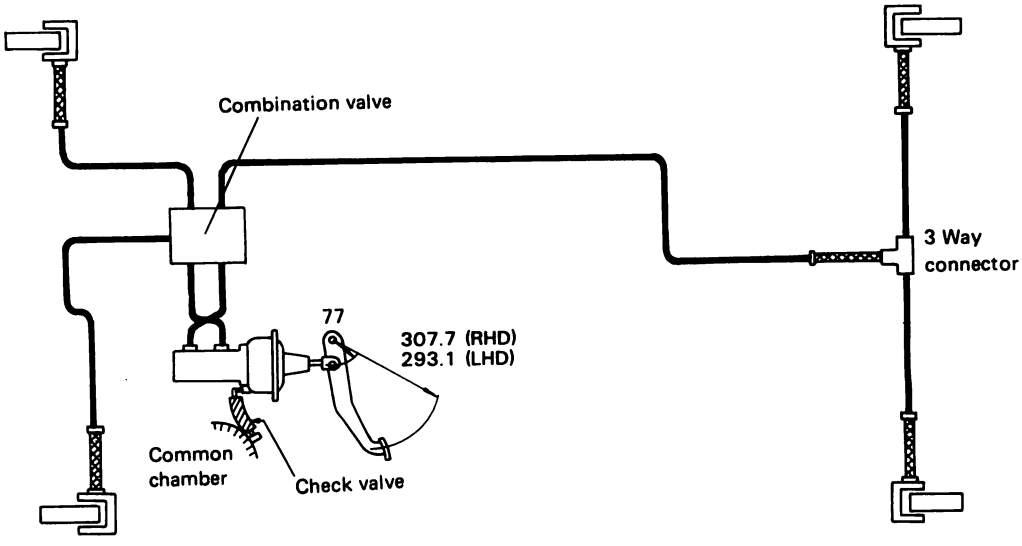
JT LHD H-2



JJ H–3

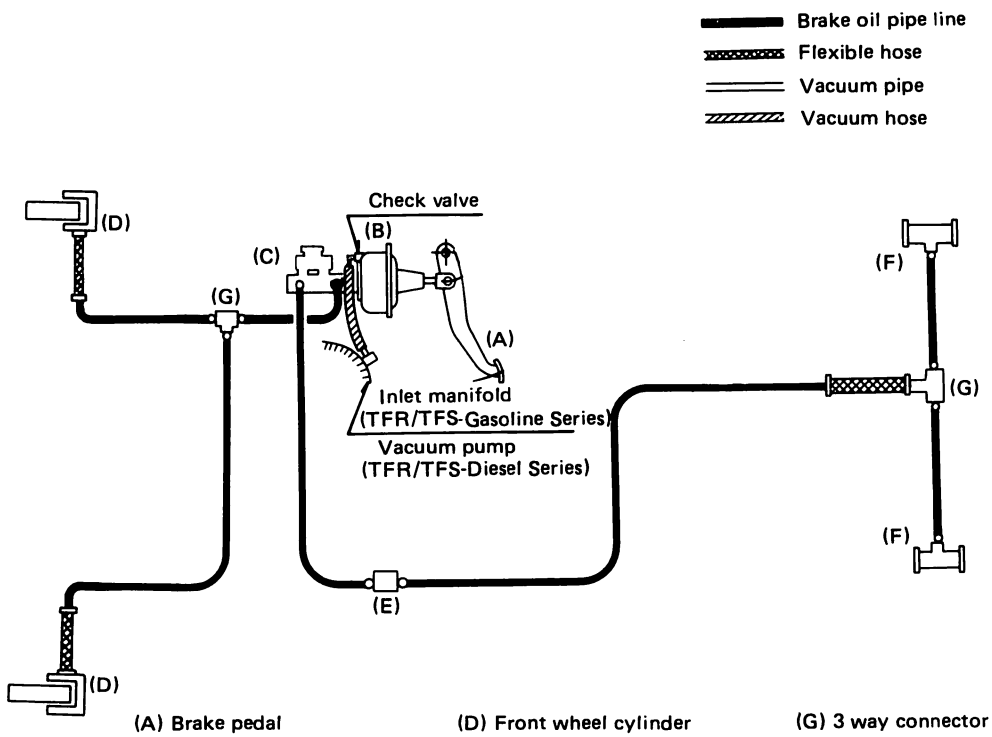


JR H–4



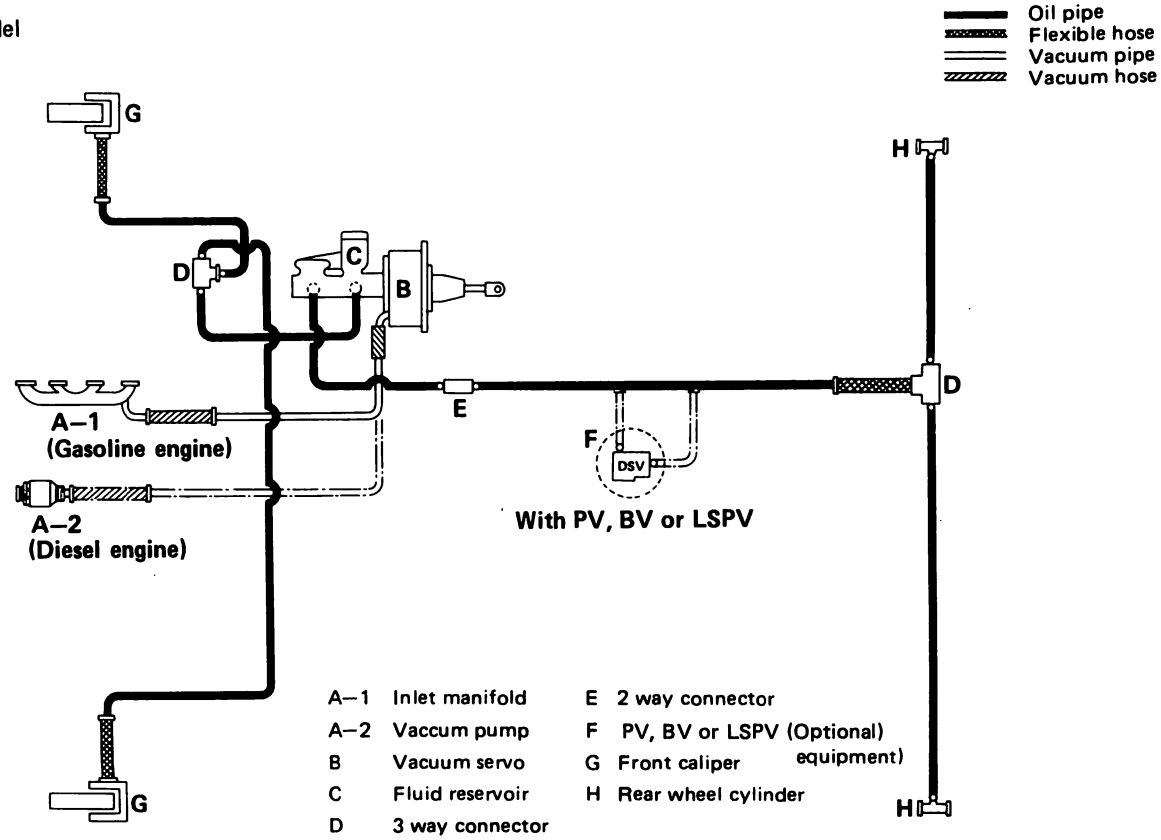
Pedal Ratio 4.00 (RHD)
Pedal Ratio 3.81 (LHD)

TFR/TFS H–6



(A) Brake pedal
(B) Vacuum servo
(C) Tandem master cylinder
(D) Front wheel cylinder
(E) 2 Way connector
(F) Rear wheel cylinder
(G) 3 way connector

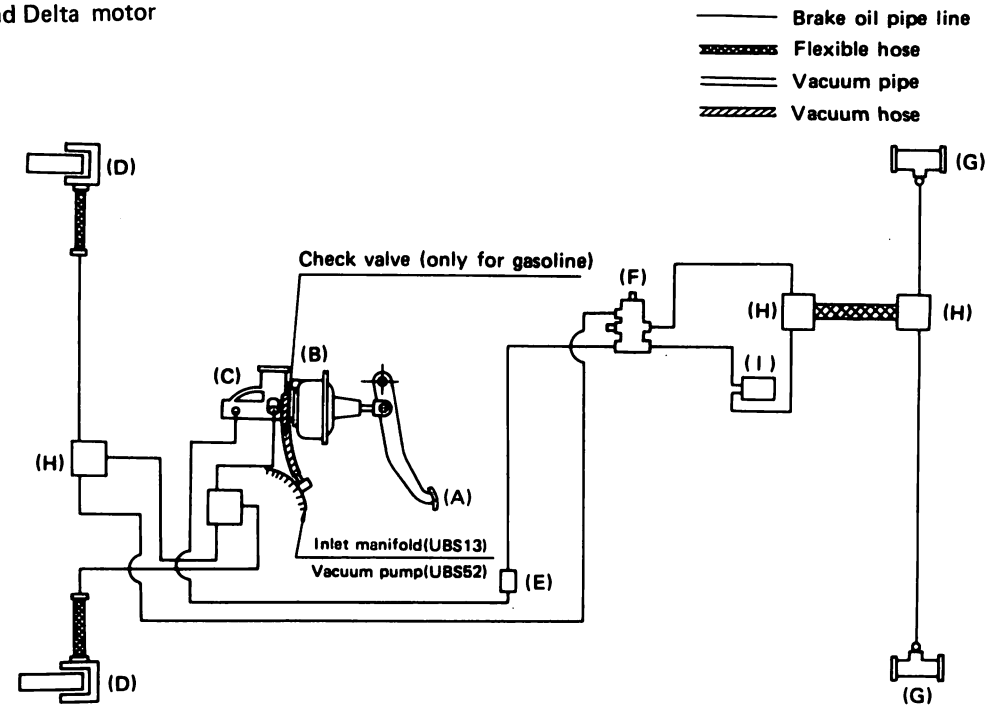
UBS H–6
Basic model



A–1 Inlet manifold
A–2 Vaccum pump
B Vacuum servo
C Fluid reservoir
D 3 way connector
E 2 way connector
F PV, BV or LSPV (Optional equipment)
G Front caliper
H Rear wheel cylinder

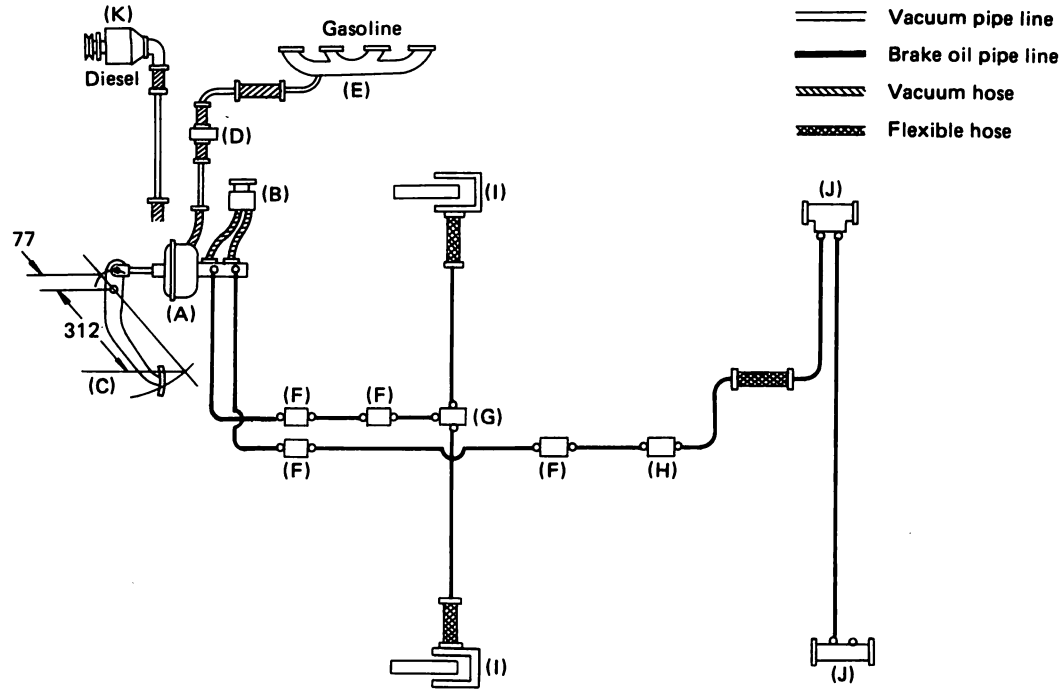
UBS H–7

For Europe and Delta motor



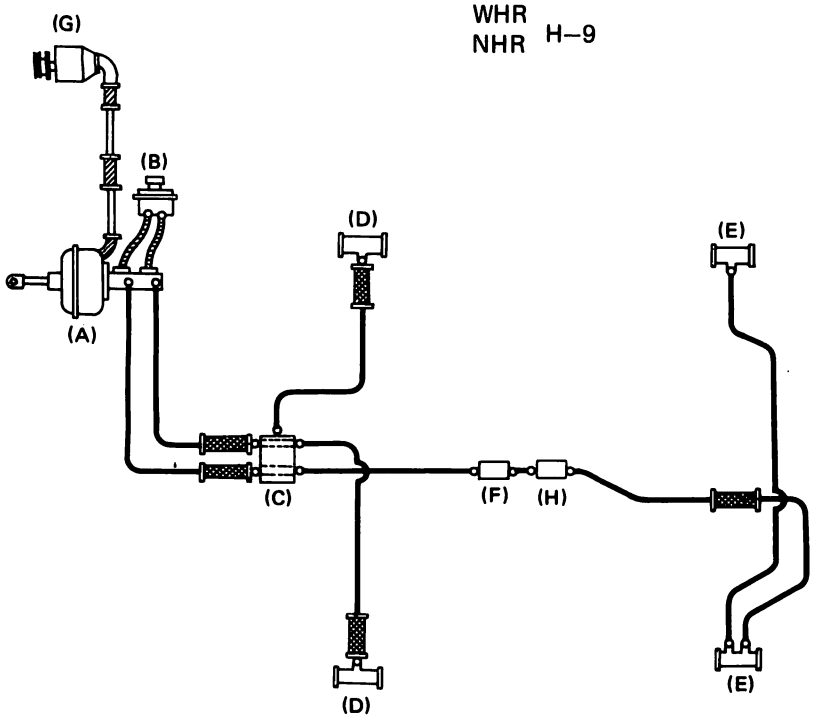
(A) Brake pedal
(B) Vacuum servo
(C) Tandem master cylinder
(D) Front wheel cylinder
(E) 2 way connector
(F) Bypass valve
(G) Rear wheel cylinder
(H) 3 way connector
(I) LSPV

WFR H–8



(A) Vacuum servo
(B) Oil tank
(C) Brake pedal
(D) Check valve (Gasoline)
(E) Inlet manifold (Gasoline)
(F) 2 way connector
(G) 3 way connector
(H) Deceleration sensing proportioning valve (VAN & BUS)
Pressure valve (WAGON)
(I) Front wheel cylinder
(J) Rear wheel cylinder
(K) Vacuum pump (Diesel)

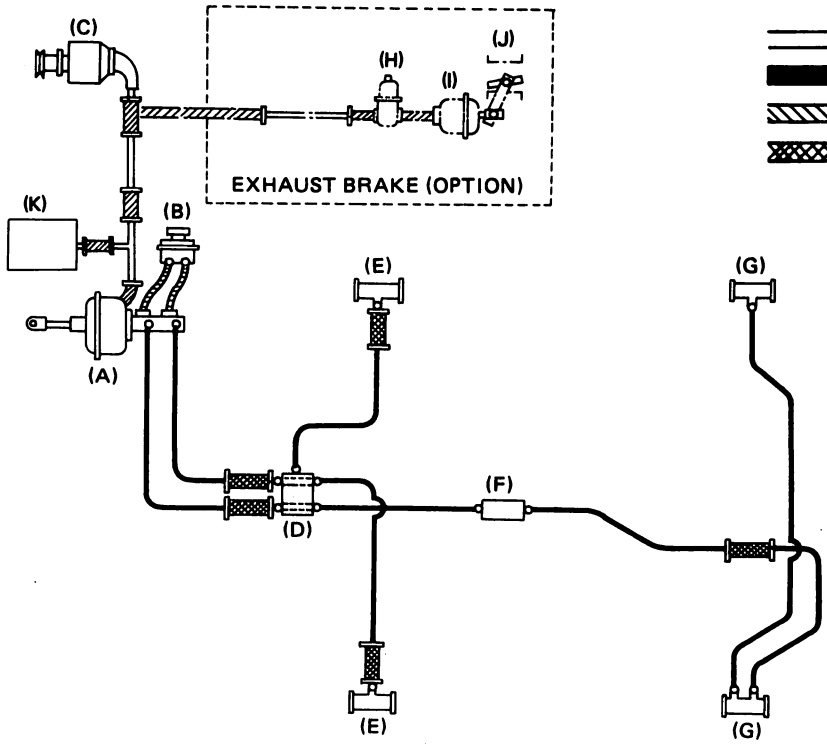
WHR
NHR H–9



Vacuum pipe line
Brake oil pipe line
Vacuum hose
Flexible hose
Oil rubber hose

(A) Vacuum servo (B) Oil tank (C) 5 way connector (D) Front wheel cylinder
(E) Rear wheel cylinder (F) 2 way connector (G) Vacuum pump
(H) Deceleration sensing proportioning valve (only for WHR)

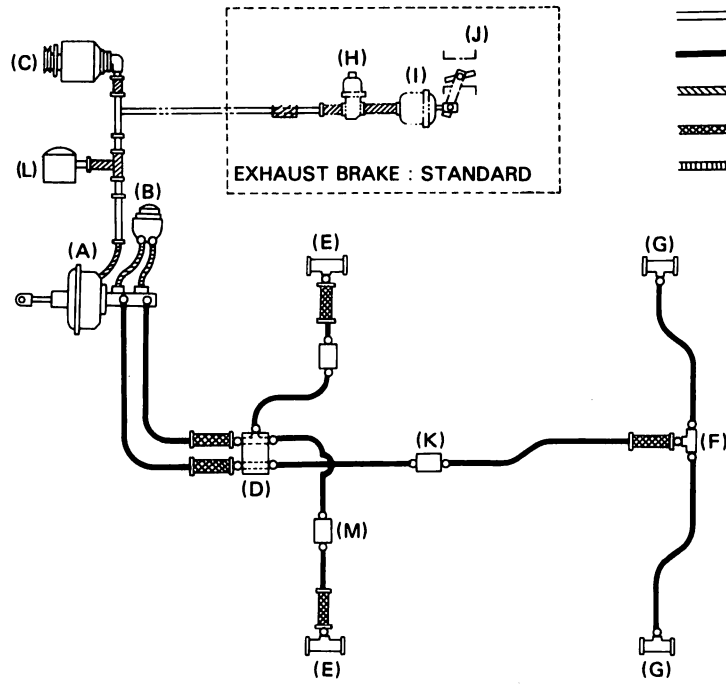
NKR
NPR H–10



Vacuum pipe line
Brake oil pipe line
Vacuum hose
Flexible hose

(A) Vacuum servo (B) Oil tank (C) Vacuum pump (D) 5 way connector
(E) Front wheel cylinder (F) 2 way connector (G) Rear wheel cylinder
(H) Magnetic valve (I) Power chamber (J) Exhaust valve (K) Vacuum tank

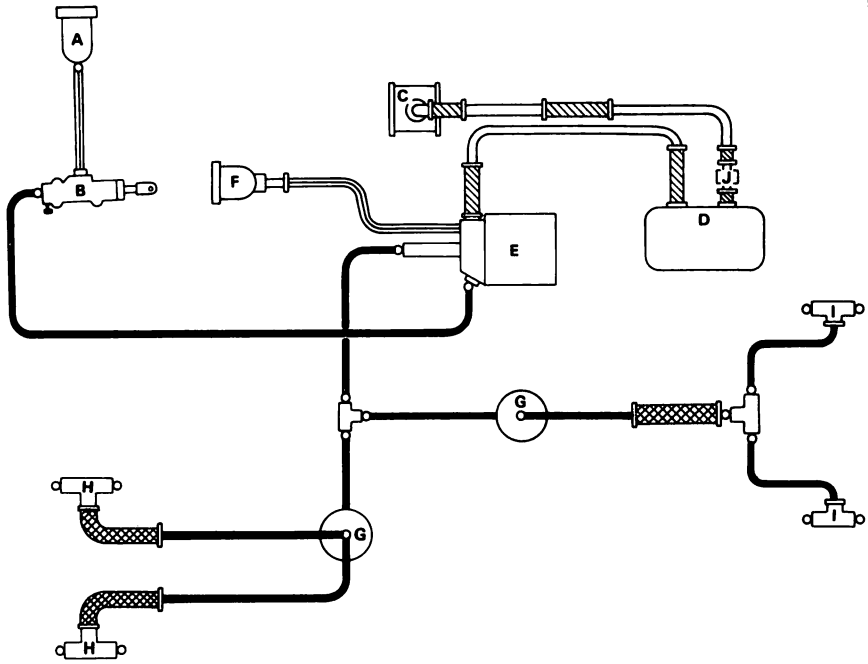
BL,BE H–11



Vacuum pipe line
Brake oil pipe line
Vacuum hose
Flexible hose
Oil rubber hose

(A) Vacuum servo
(B) Oil tank
(C) Vacuum pump
(D) 5 way connector
(E) Front wheel cylinder
(F) 3 way connector
(G) Rear wheel cylinder
(H) Magnetic valve
(I) Power chamber
(J) Exhaust valve
(K) 2 way connector
(L) Vacuum Tank
(M) 2 way connector (only for BL, BE)

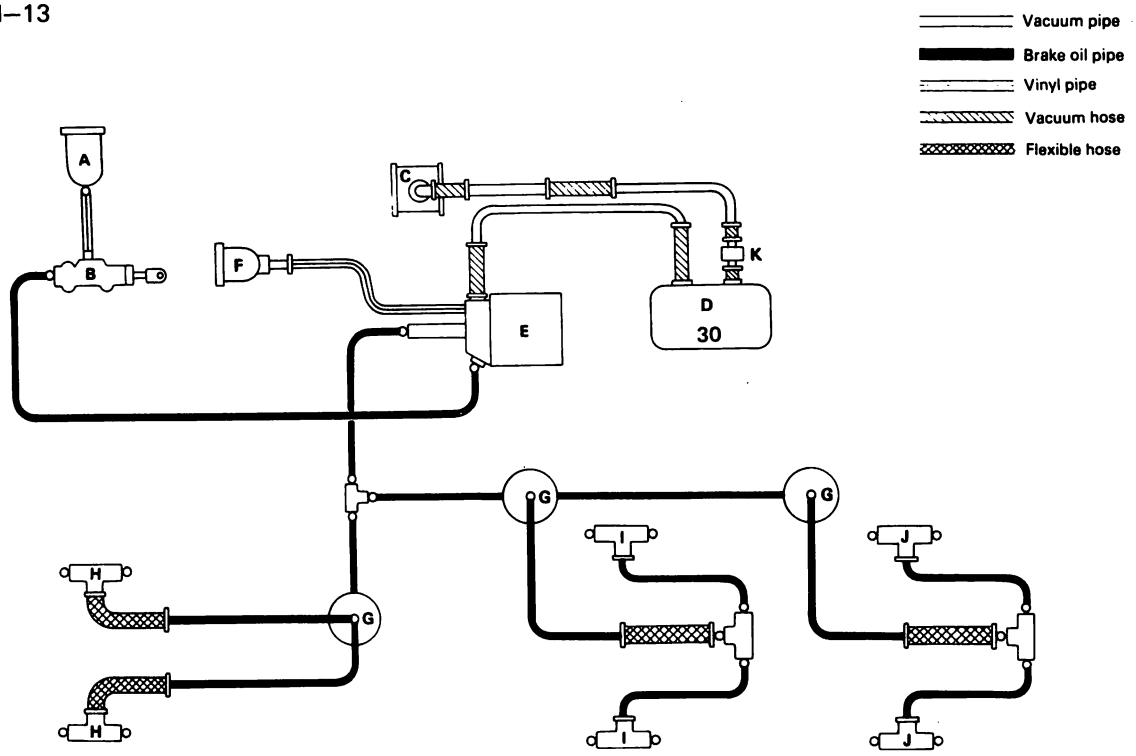
FSR HTR H–12



Vacuum pipe
Brake oil pipe
Vinyl pipe
Vacuum hose
Flexible hose

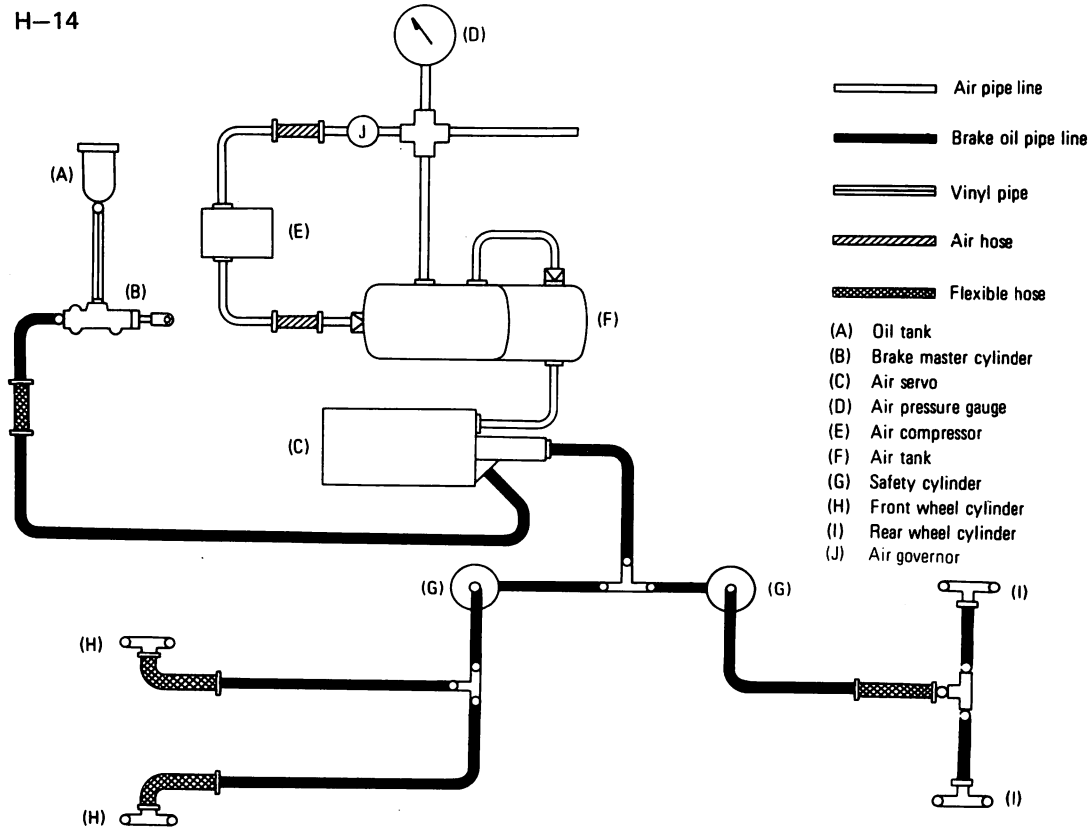
(A) Brake fluid reservoir
(B) Brake master cylinder
(C) Vacuum pump
(D) Vacuum reservoir
(E) Vacuum servo
(F) Air cleaner
(G) Safety valve
(H) Front wheel cylinder
(I) Rear wheel cylinder
(J) Check valve

HTW H–13

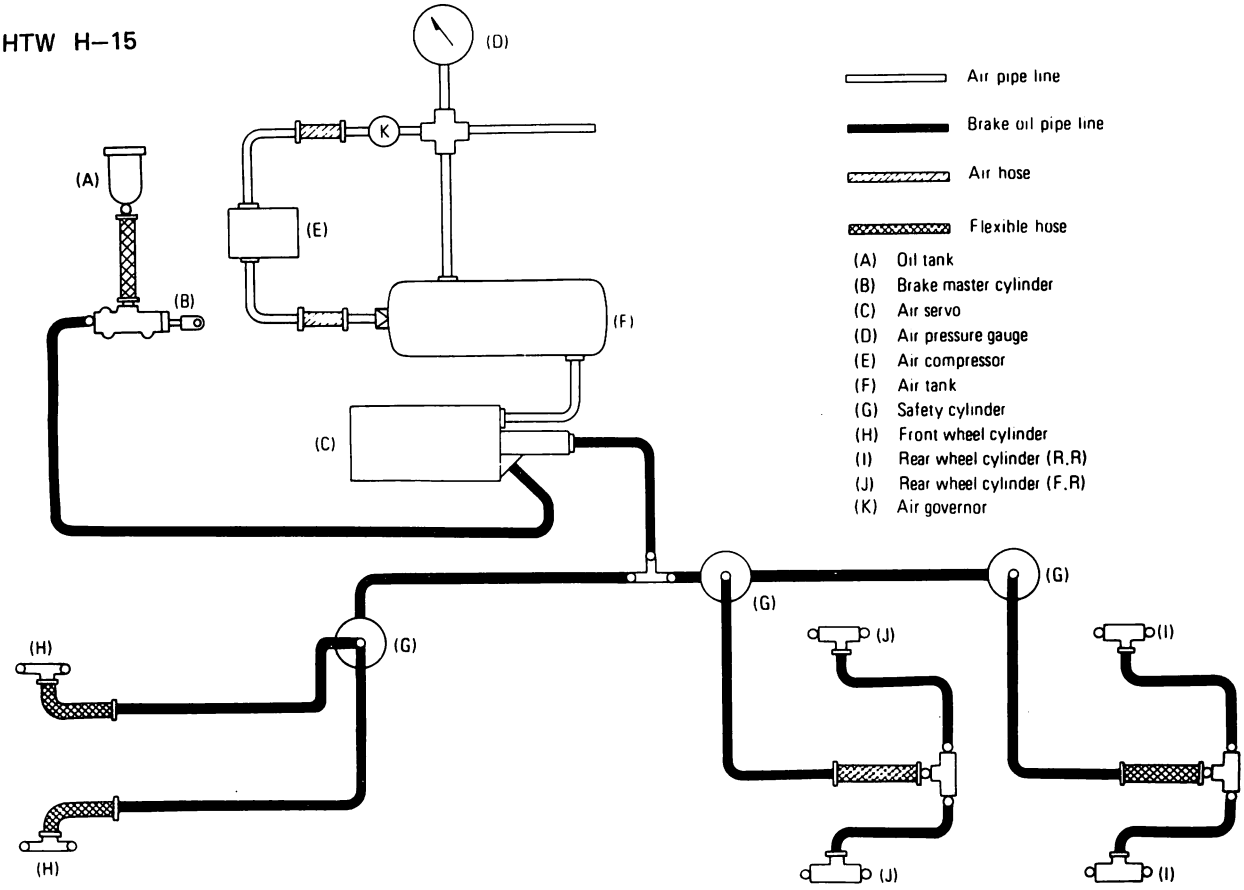


(A) Brake fluid reservoir
(B) Brake master cylinder
(C) Vacuum pump
(D) Vacuum reservoir
(E) Vacuum servo
(F) Air cleaner
(G) Safety valve
(H) Front wheel cylinder
(I) Rear wheel cylinder-Forward rear
(J) Rear wheel cylinder-Rearward rear
(K) Check valve
(L) Ejector
(M) Check valve

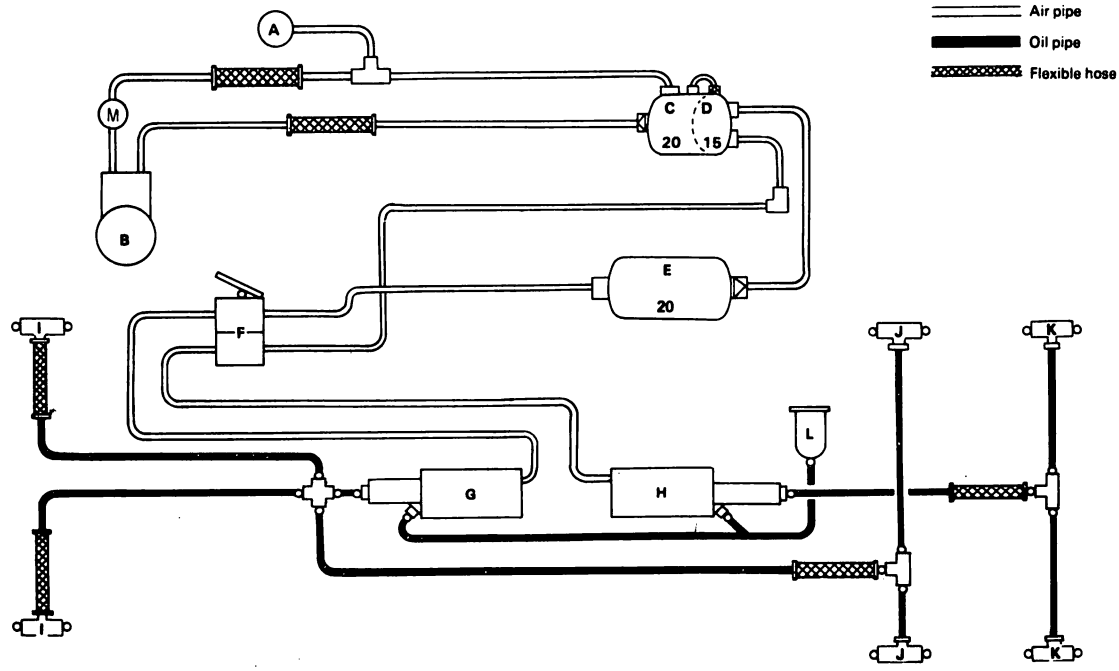
HTR
DVR H–14
C–R



HTW H–15

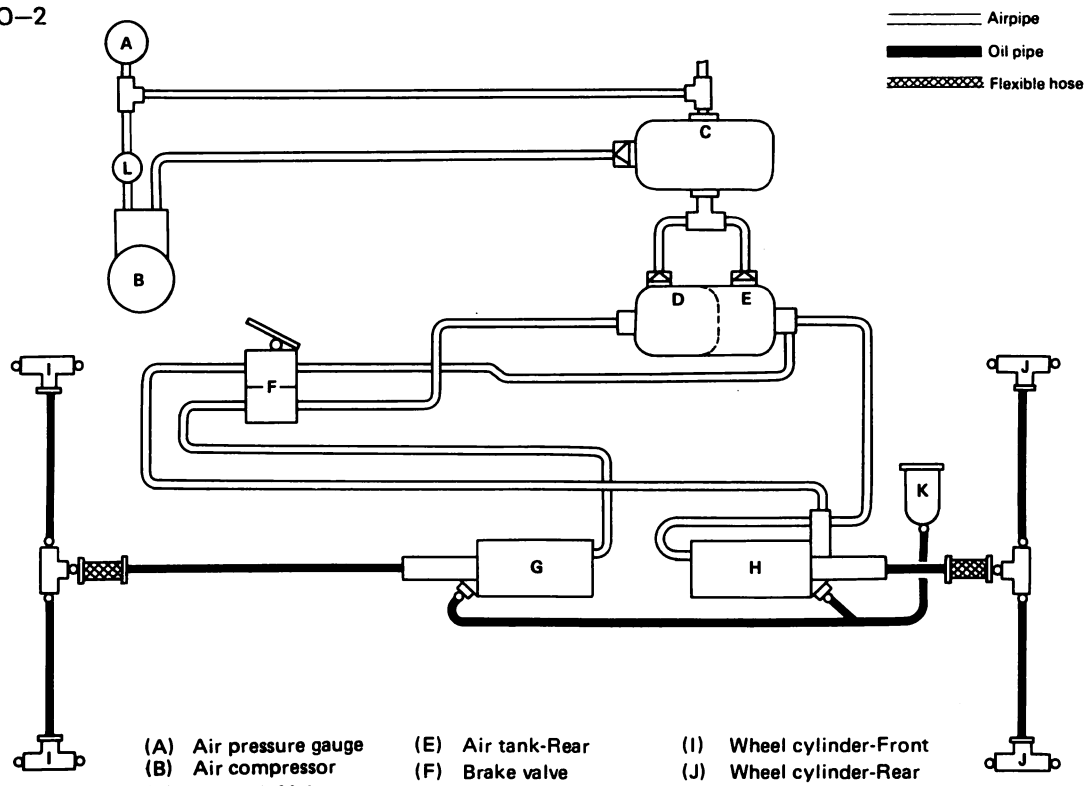


DXZ AO–1



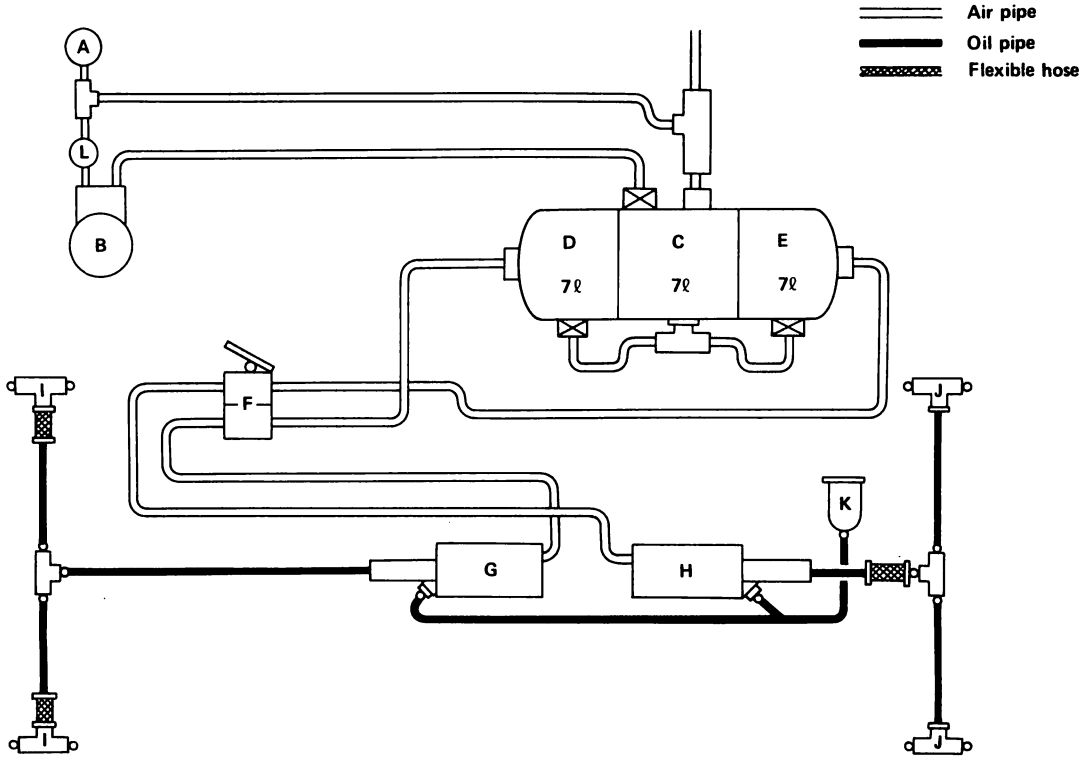
(A) Air pressure gauge
(B) Air compressor
(C) Air tank-main
(D) Air tank-main
(E) Air tank forward rear
(F) Brake valve
(G) Air master large-front and forward rear
(H) Air master small-Rearward rear
(I) Wheel cylinder-Front
(J) Wheel cylinder-Forward rear
(K) Wheel cylinder-Rearward rear
(L) Brale fluid reservoir
(M) Air governor

CVR AO–2



(A) Air pressure gauge
(B) Air compressor
(C) Air tank-Main
(D) Air tank-Front
(E) Air tank-Rear
(F) Brake valve
(G) Air master-Front
(H) Air master-Rear
(I) Wheel cylinder-Front
(J) Wheel cylinder-Rear
(K) Brake fluid reservoir
(L) Air governor

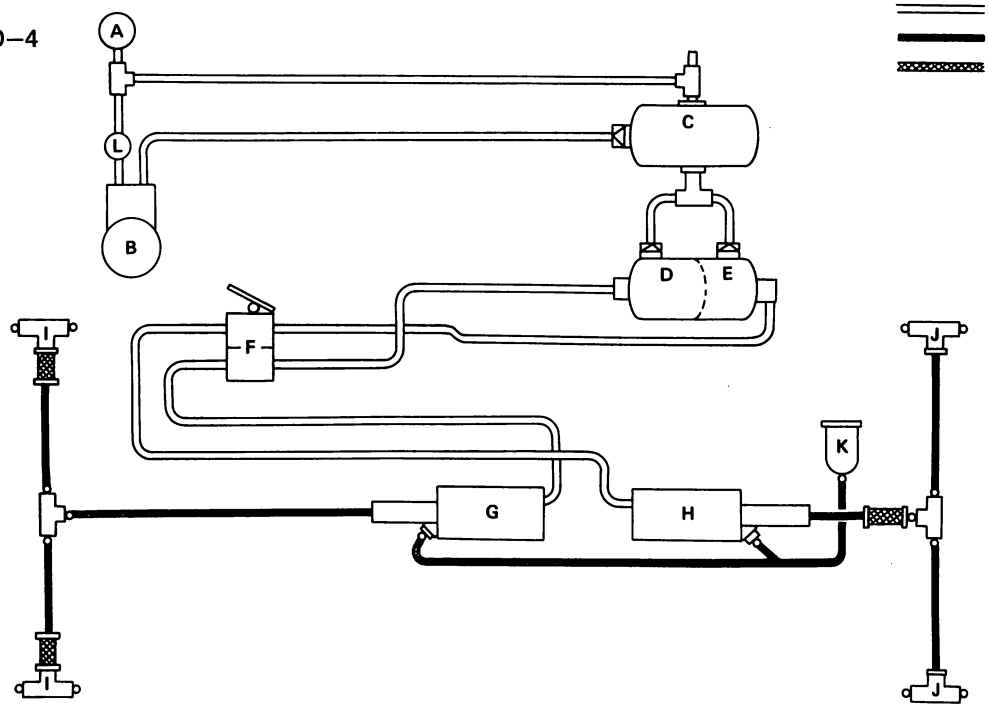
FSR
FSS AO–3
FTS



(A) Air pressure gauge
(B) Air compressor
(C) Air tank - Main
(D) Air tank - Front
(E) Air tank - Rear
(F) Brake valve
(G) Air master-Front
(H) Air master-Rear
(I) Wheel cylinder - Front
(J) Wheel cylinder - Rear
(K) Brake fluid reservoir
(L) Air governor

FSR
FVR
LT
MT

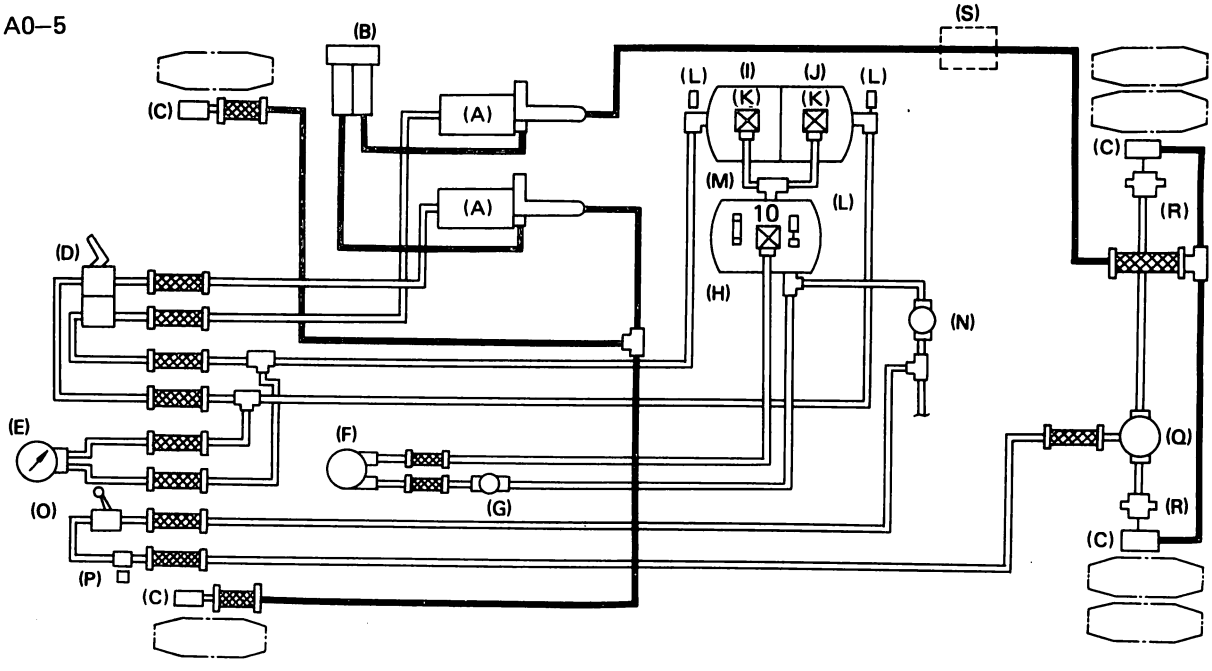
AO–4



(A) Air pressure gauge
(B) Air compressor
(C) Air tank - Main
(D) Air tank - Front
(E) Air tank - Rear
(F) Brake valve
(G) Air servo - Front
(H) Air servo - Rear
(I) Wheel cylinder - Front
(J) Wheel cylinder - Rear
(K) Brake fluid reservoir
(L) Air governor

WHEEL PARKING BRAKE

AO–5



; Oil pipe ; Air pipe ; Flexible pipe

(A) Brake Power Unit (Air master)
(B) Reservoir for Brake Fluide (2 chamber)
(C) Wheel Cylinder
(D) Dual Brake Valve
(E) Dual Air Gauge
(F) Air Compressor
(G) Governor
(H) Air Reservoir-Supply (20L)
(I) Air Reservoir-Service Brake 1 (13L)
(J) Air Reservoir-Service Brake 2 (13L)
(K) Check Valve
(L) Low Pressure Switch (Air reservoir)
(M) Safety Valve
(N) Pressure Protection Valve
(O) Parking Brake Control Valve
(P) Low Pressure Switch (Spring brake)
(Q) Quick Release Valve
(R) Spring Brake Chamber
(S) Load Sensing Proportioning Valve*

*Add (S) in case of Delta Motor shipment.

SECTION 3

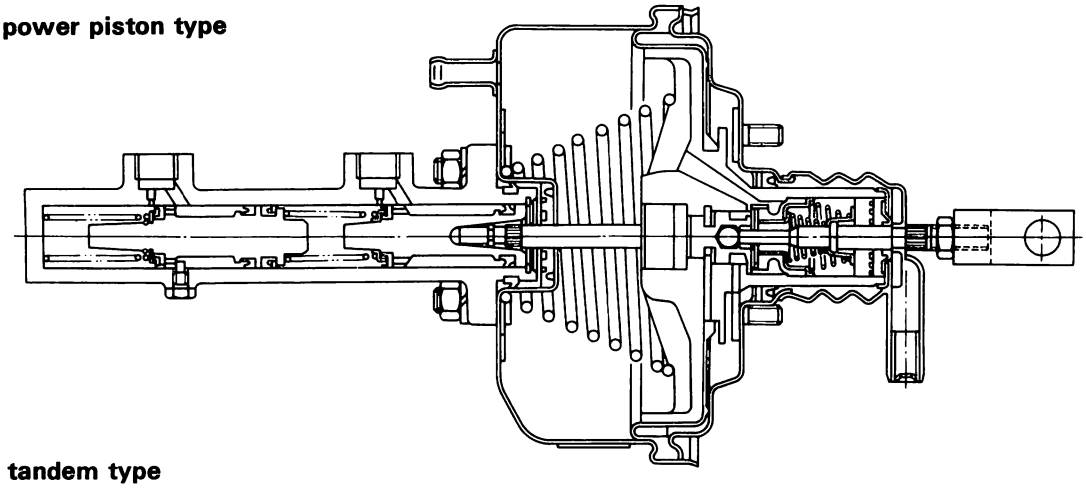
CONSTRUCTION AND OPERATION OF BRAKE UNIT

Mastervac

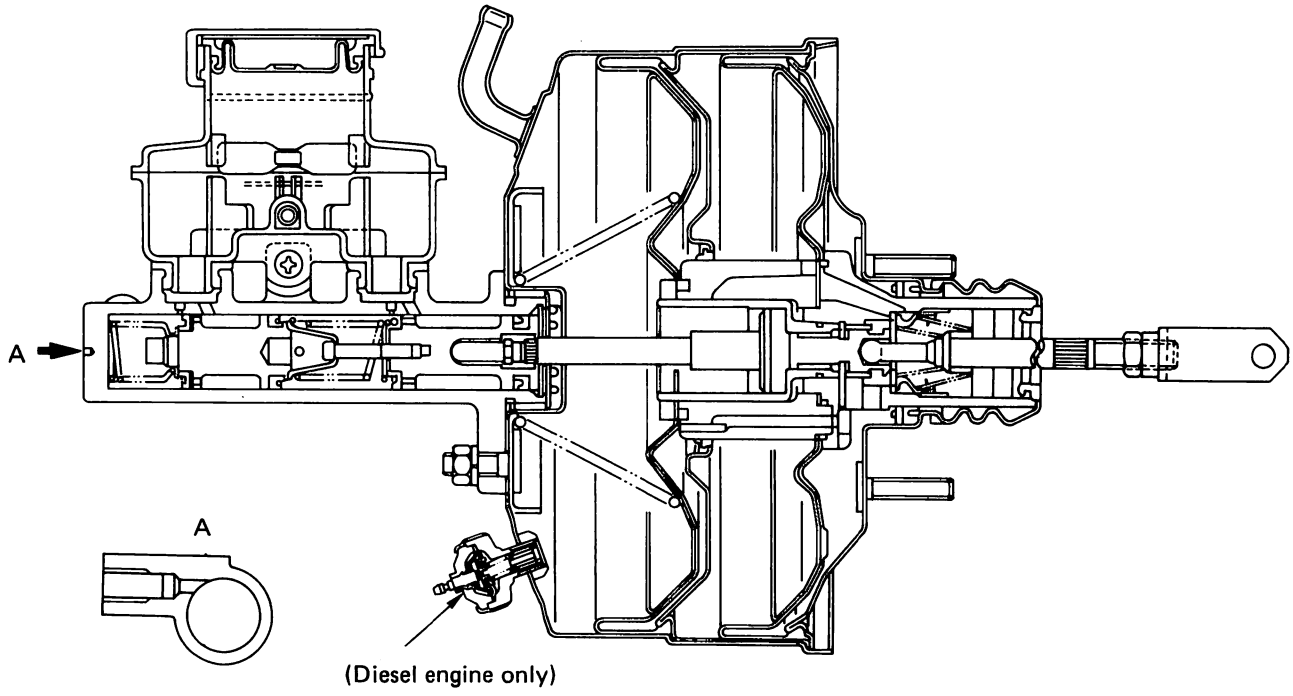
Outline of mastervac

The mastervac is a type of direct acting vacuum servo system and is generally used as a hydraulic brake booster for light and medium duty vehicles. It utilizes the difference between the atomospheric pressure and negative pressures provided by engine air intake manifold or vacuum pump.
The mastervac unit is installed in place between the brake pedal and master cylinder, and the power section is compactly built for convenience of installation.
When the mastervac unit is installed, stronger brake force is obtained with ligher foot pressure. The power section includes valve for controlling servo action and parts for providing the operator with a brake pedal feel.

Single power piston type

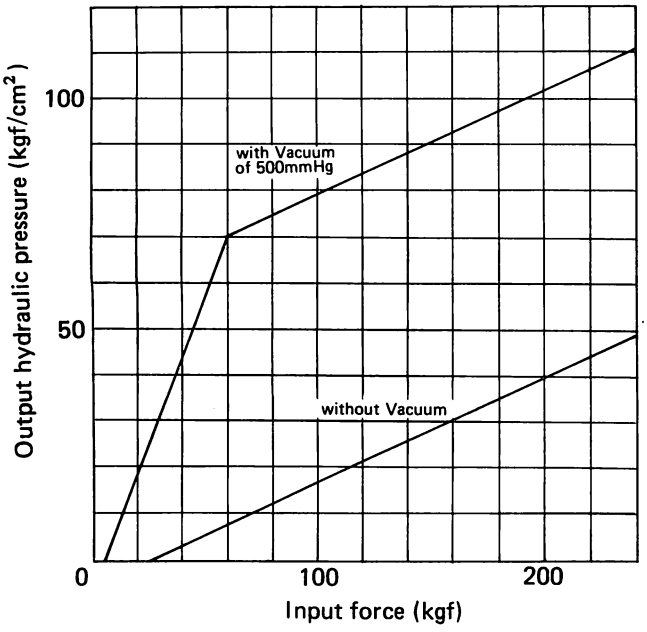


8 inch tandem type
Mastervac and master cylinder

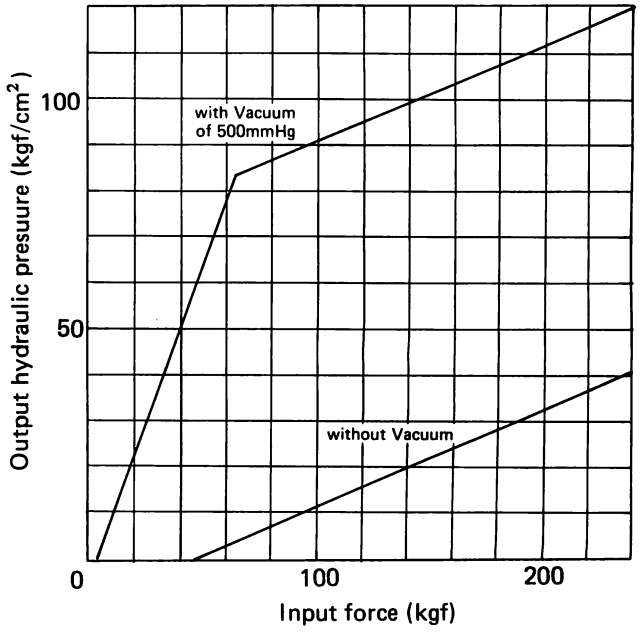


Vacuum booster and master cylinder performance characteristic curve (Calculated value)

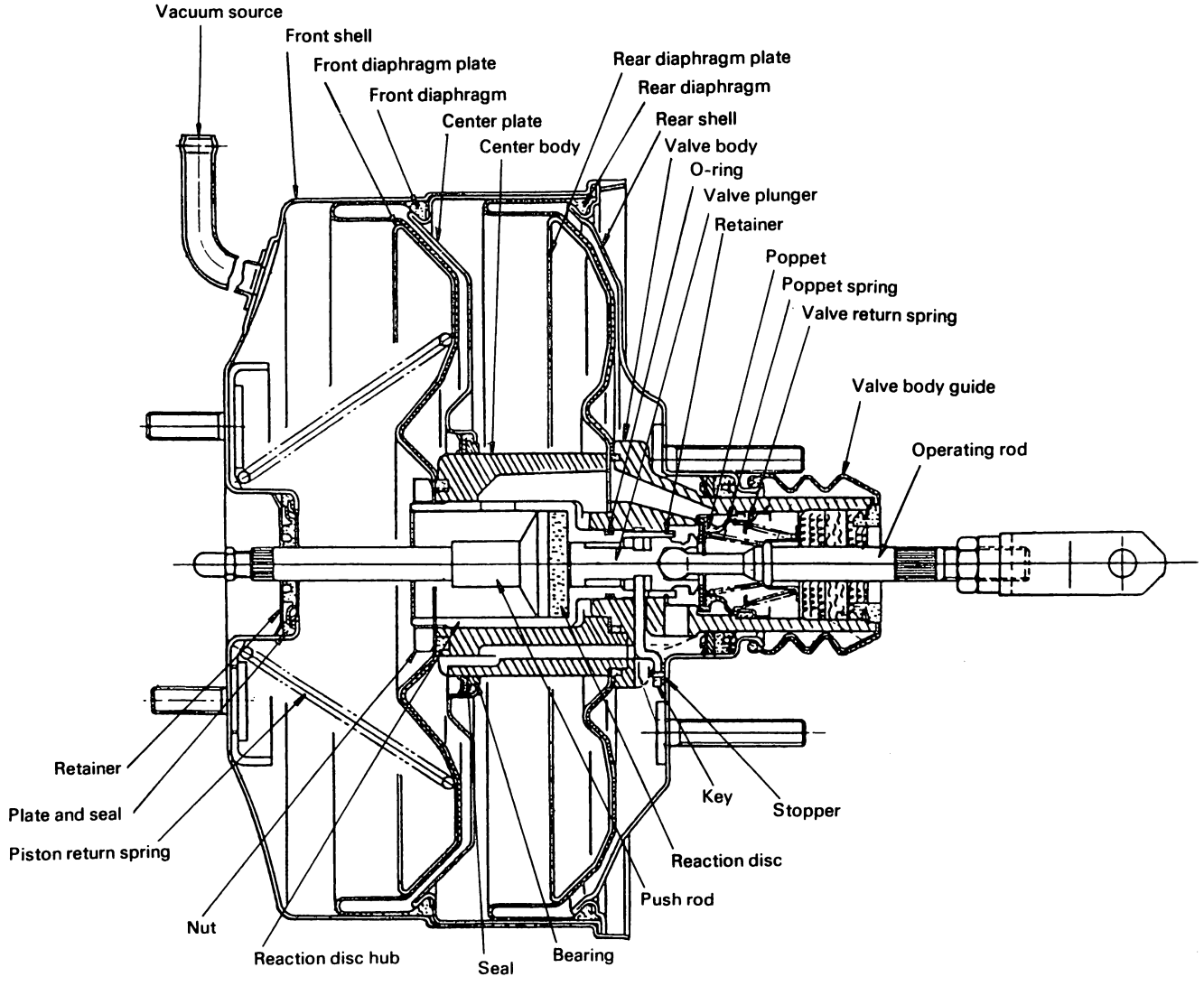
9″ single type



8″ tandem type



Construction



Construction

The internal structure of the tandem-type mastervac is shown in the figure. The power cylinder contains a piston of dual structure in which the piston return spring is installed at the left, the front diaphragm plate, the front diaphragm and the center body and center plate assembly at the center, and the rear diaphragm, the rear disphragm plate and the valve body in the rear piston section. The parts are put between and secured by the retainer at the right end and the nut at the left end via the reaction disc hub passing through the center.

The power cylinder is composed of a front and a rear shell, with the center plate outer edge caught between their joining parts and they are united by the front shell V-groove.

As the center plate is attached in such a state that the front disphragm is pressed to the front shell's inner circumference and the rear diaphragm to the rear shell grooved portion, the outside air is shut off the power cylinder.

The right and left chambers of the front diaphragm are kept airtight by the seal fit into the center plate assembly center hole and the center body.

The rear diaphragm is guided by the rear diaphragm plate and the valve body, which in turn is guided by the tube sliding in the rear shell. The seal installed in the rear shell maintains airtightness between the rear shell and the guide tube.

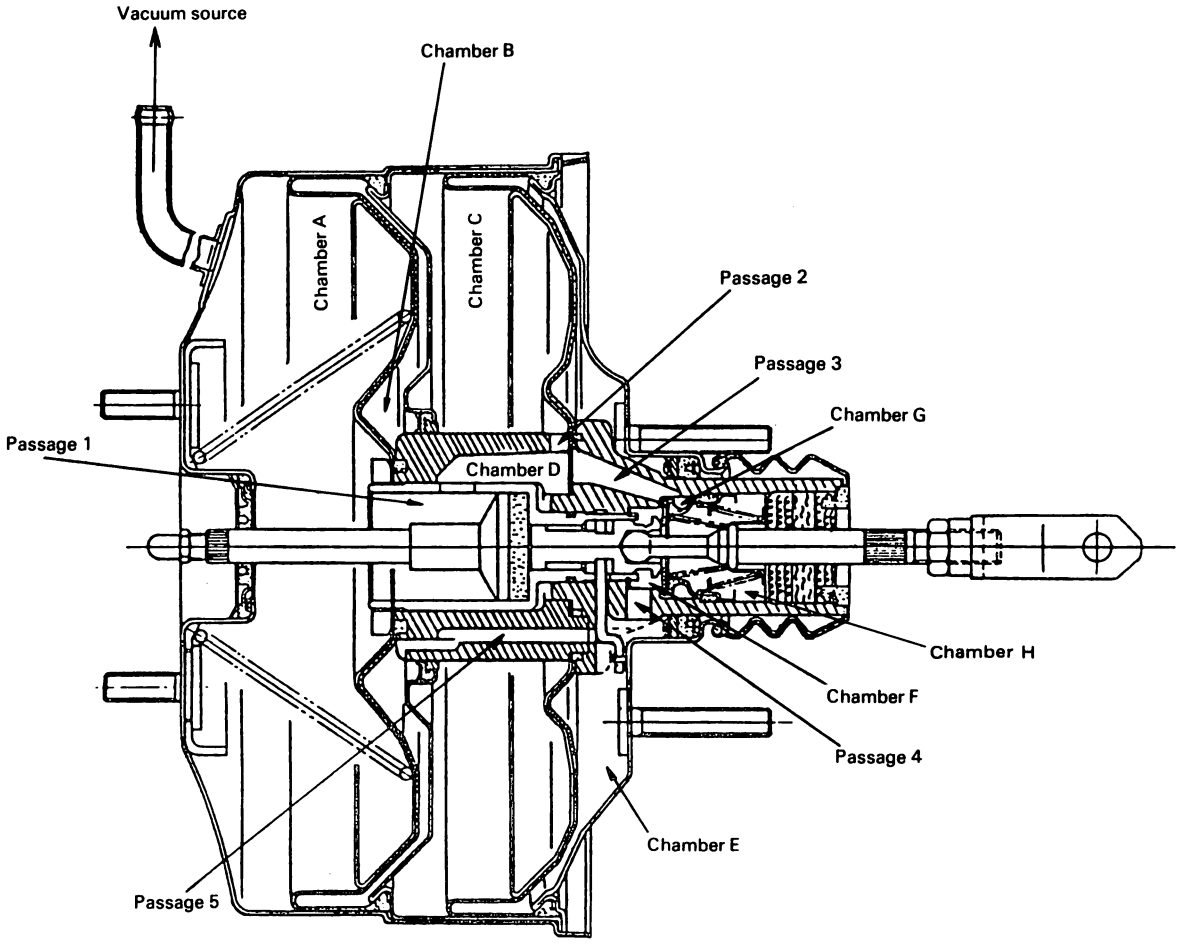
In the guuide tube of the valve body, the valve rod assembly is installed. On the valve rod assembly, a valve, spring, etc., which function to transmit the driver's will to the brake system, are attached. The valve body guard protects the guide tube's outer circumference from dust and water entry.

In the center of the reaction disc hub, the pushrod, which pushes the master cylinder piston, is installed. The right end of the pushrod is in close contact with the reaction dis. The reaction disc allows the vlave body and the pushrod to make different movements from each other.

The pushrod passes through the front diaphragm plate and the front shell, and protrudes to the outside (left side). The sliding portion of the front shell is kept airtight by the plate & seal assembly.

Operation

(1) When not operating



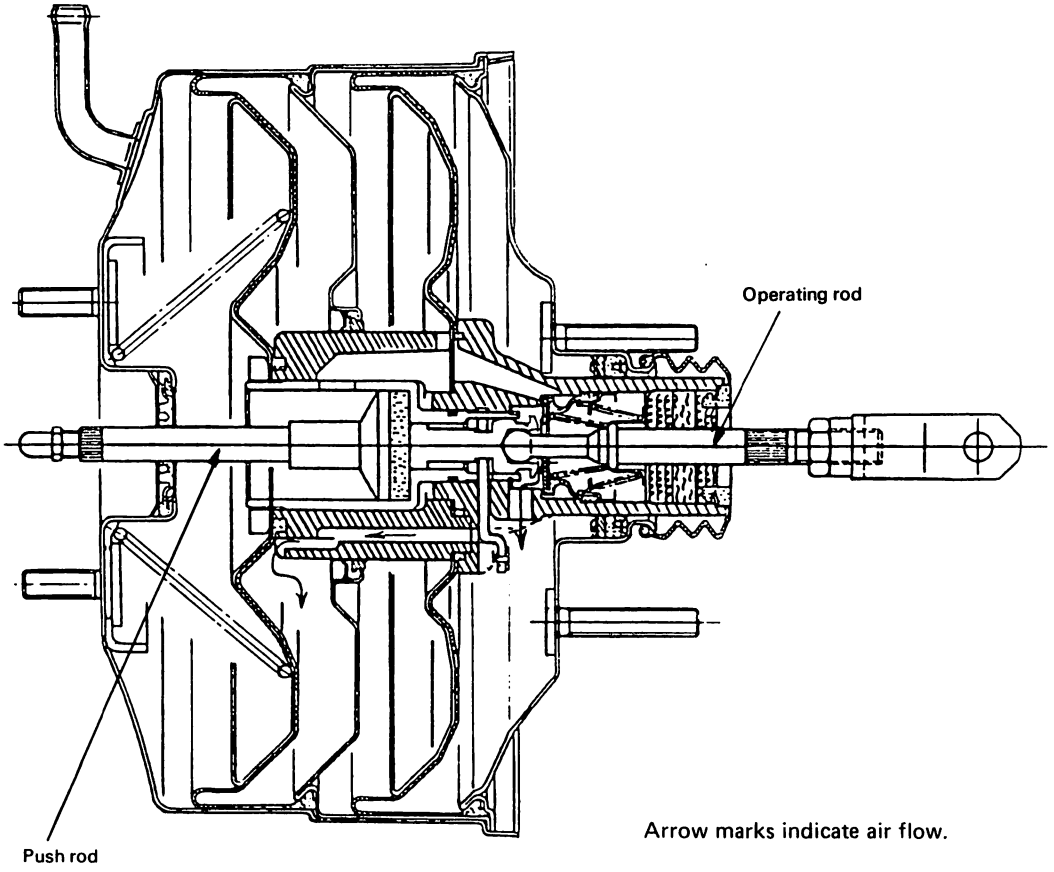
In the non-operating condition, as no force is applied to the brake pedal, the operating rod and the valve plunger caulked to the operating rod are pressed to the right of the valve body by the valve return spring, the vacuum valve is open, and the air valve is shut off.

Negative pressure generated in the intake manifold after engine start of generated by the vacuum pump is conducted via the check vlave installed i the vacuum line and introduced throught the front shell connector into the power chamber.

The tandem-type mastervac has two sets of operation chambers (A & B and C & D), place on stright line. Each set works in coordination with the single-type mastervac, performing the same operation. These two sets of operation chambers are separated by the center plate assembly. As chambers A is connected to chamber C through passage 1 → camber D → passage 2, → then chamber C, and to chambers B and E throgh passage 3 → chamber F → passage 4 → passage 5 → , then chamber B, both the front and rear shells are already under vacuum, and the front and rear diaphsragms connected through the reaction disc hub are pressed to the right side of the power chamber.

Air enters the chamber H through the filter, and as is it shut off from chamber F by the plunger air vlave, the front and rear diaphragms do not operate.

(2) When operating



When the brake pedal is depressed and the depressing force surpasses the pedal return spring and the valve return spring, the valve plunger and poppet assembly attached to the operating rod move to the left inside the valve body guide tube, and the peppet assembly comes in contact with the valve body seat by the poppet spring force, closing the vacuum valve.

When the brake pedal is further depressed after the vacuum valve has been closed, the valve plunger is separated from the poppet assembly, opening the air valve, and air that was occupying up to chamber H flows into chamber E through passage 4, then flows into chamber B through passage 5.

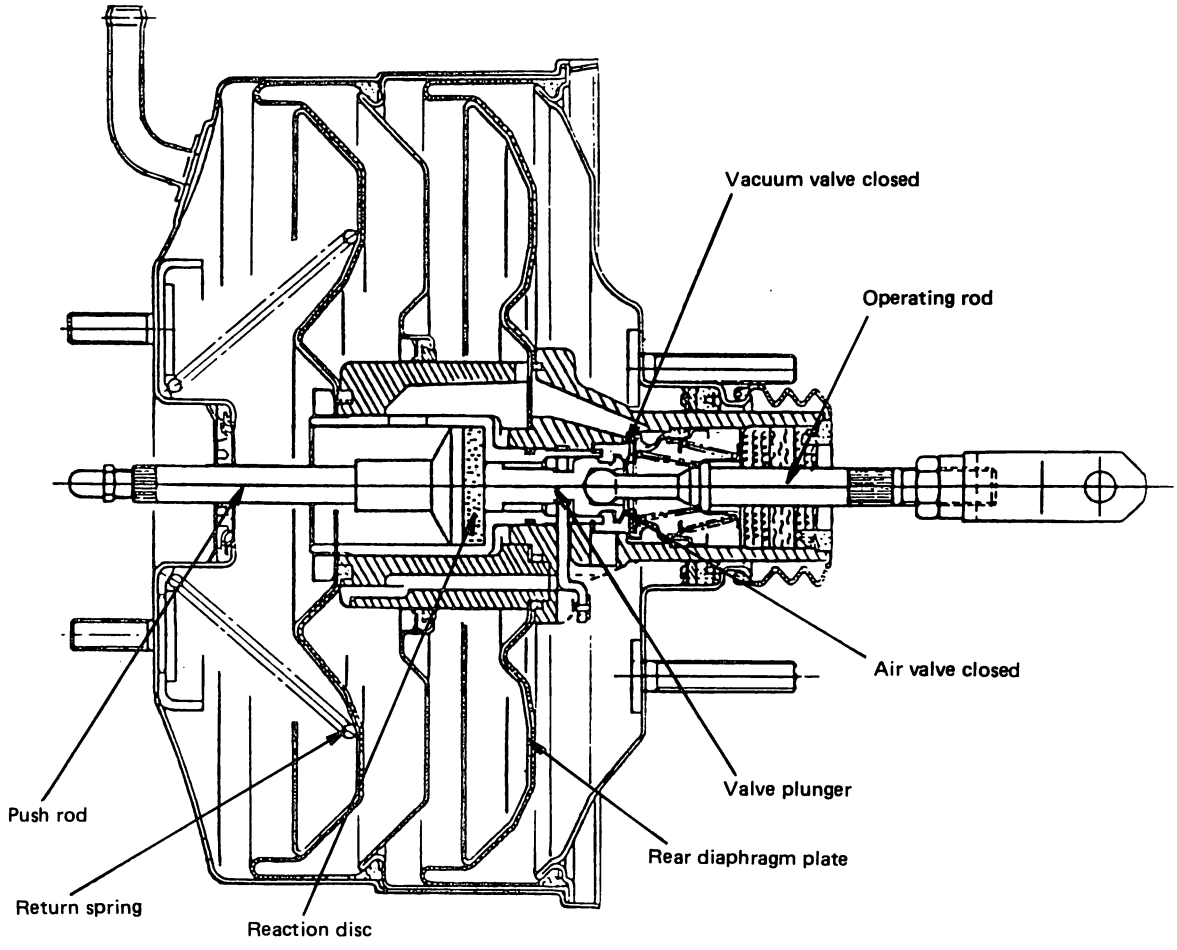
This air flow reduces negative pressure inside chamber E and B, producing a pressure difference between both sides of the power piston. When the force generated by this pressure difference surpasses the piston return spring force, the two pistons move inside the power cylinder from right to left while applying force to the pushrod, which pushes the master cylinder piston, generating a high hydraulic pressure with little depressing force.

This hydraulic pressure produces a reaction force at the piston, which is transmitted to the pushrod from the master cylinder piston, and the rubber reaction disc.

The rubber reaction disc works as a liquid to transmit the reaction force from the pushrod to the power piston and the valve plunger.

At this time, both the air and the vacuum valves are closed and the depressing and the reaction forces are evenly balanced.

(3) When balanced

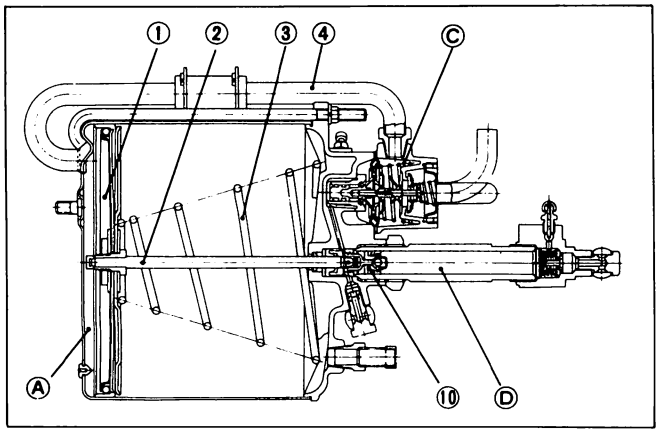


All of pressure, which is generated in proportion to the hydraulic pressure produced in the master cylinder, is transmitted via the pushrod to the reaction disc. The reaction disc transmits the pressure through the reaction disc hub to the valve body as well as to the valve plunger.
The force transmitted to the valve plunger is further transmitted to the operating rod, acting on the brake pedal and offering to the driver a resistance proportional to the braking force.
The reaction force acting on the valve plunger is balanced with the depressing force applied by the driver and transmitted from the operating rod to the valve plunger, and the reaction force acting on the valve body is balanced with the force generated by the pressure difference between the front and rear pistons. Therefore, part of the force required for braking is applied by the driver, and the rest is generated by the front and rear pistons, and the driver can always feel a resistance proportional to braking power when applying the brake. When depressing and reaction forces get balanced, the valve plunger closes the air valve.

Hydromaster

Outline of hydromaster

The hydromaster is a type of vacuum servo unit primary designed to multiply hydraulic brake force and is mainly used for medium-duty trucks.
Similar to master-vac, the hydromaster utilizes the difference between the atmospheric pressure and negative pressure to provide a servo action.
In the hydraulic brake system of the conventional design, the brake force is increased in proportion to the foot pressure applied to the brake pedal. However, when the hydromaster is installed, the power cylinder is actuated, by the difference between the atmospheric pressure and negative pressure, to multiply the fluid pressure applied to the wheel cylinders, so that a strong brake force is obtained even when a slight foot pressure is applied to the brake pedal. This servo action helps to relieve the operator of fatigue and insures positive stops even in an emergency.
Similar to the case of master-vac, normal brake action is provided but without servo action even when the hydromaster is malfunctioning.
Negative pressure delivered eiher by the vacuum pump or from the throttle valve through the ejector (DA series engines) has been used for actuating the hydromaster, but recently, the vacuum pump is generally used as a vacuum source for it is dependability.



Construction

Power cylinder and power piston

The power cylinder assembly includes the power piston ①, push-rod ② and return spring ③, and power chamber Ⓐ at left side of the piston ① is communicated with the relay valve chamber Ⓒ past the control tube ④.
The push-rod ② extending into the hydraulic cylinder Ⓓ is fitted with the hydraulic piston ⑩ at one end.

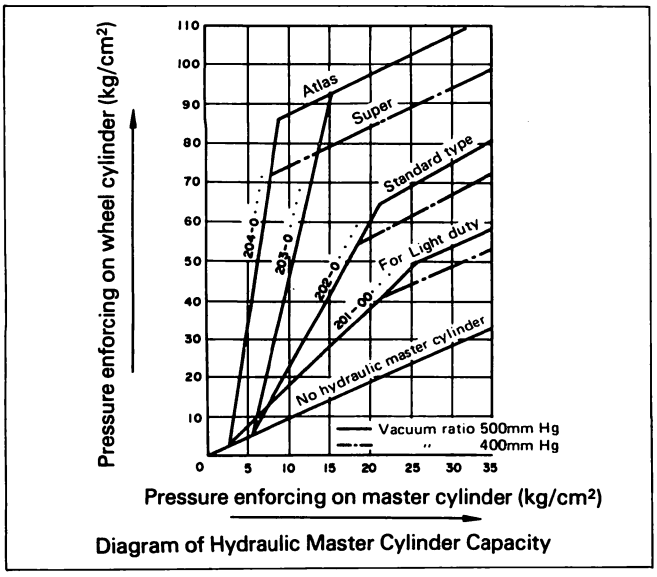


Diagram of Hydraulic Master Cylinder Capacity

Hydromaster performance diagram.

For selective application, the hydromaster is available in 4 different types, namely: light-duty, standard, super and attlas.

Airmaster

Outline of Airmaster

The Airmaster is nearly equal to hydromaster in the basic structure and operating principle but unlike the hydromaster which utilizes the difference between negative pressure and atmospheric pressure to provide a servo action, the Airmaster relies on the difference between the atmospheric pressure and compressed air obtained from the air compressor.

Features of Airmaster

(1) As the compressed air of higher than 7 kg/cm^2 is used to provide a difference of pressure between each side of the power piston which greater than that utilized by the Hydromaster for servo action, power piston can be made smaller in diameter and provides stronger servo action.
(2) Easy to handle and insures storng brake action which can be compared to air brake system.
(3) Requires lesser compressed air comparing to air brake system and normal hydraulic brake action is maintained to insure safe stops even when a malfunction has developed in the air circuit.

The air servo system can be classified bradly into hydraulic air servo type and air-over hydraulic servo type, but both types are similar in basic operating principles. However, the relay valve for actuating the power piston is classified into diaphragm type and piston type according to the costruction, and in some instances, a system without relay valve is employed depending on the curcuit arrangement.

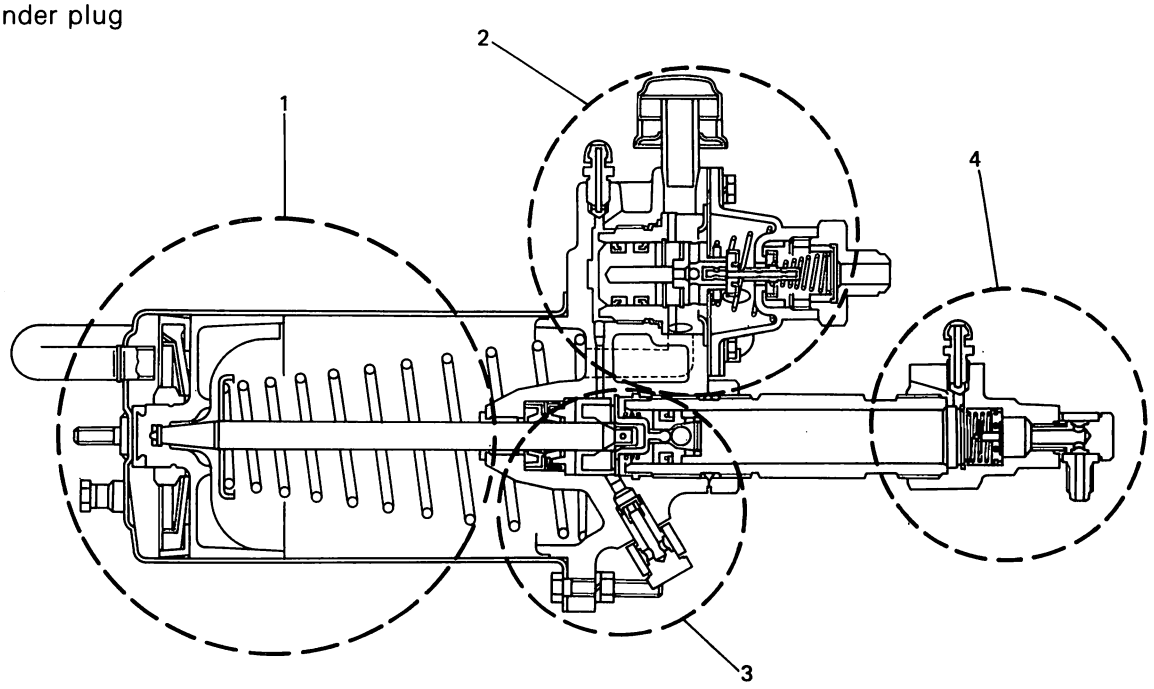
Hydrualic air assisted type

Construction

The hydraulic air servo type consists basically of the following 4 major components:

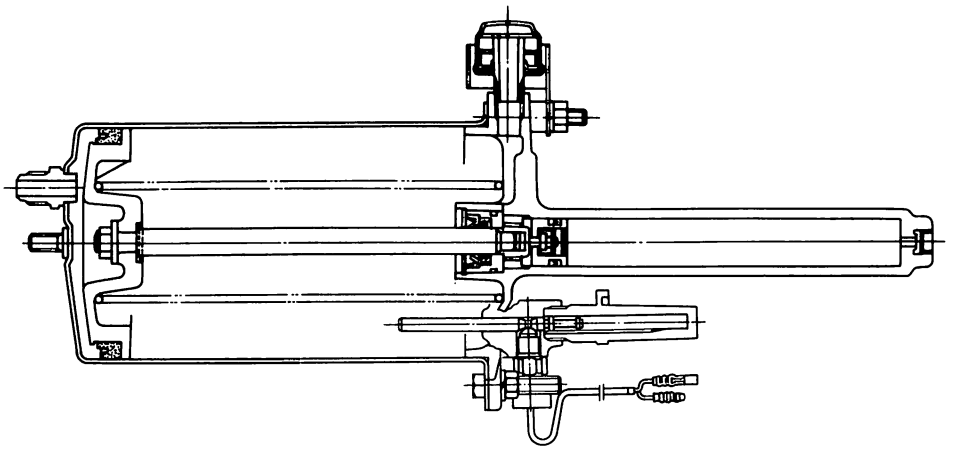
The main components include:

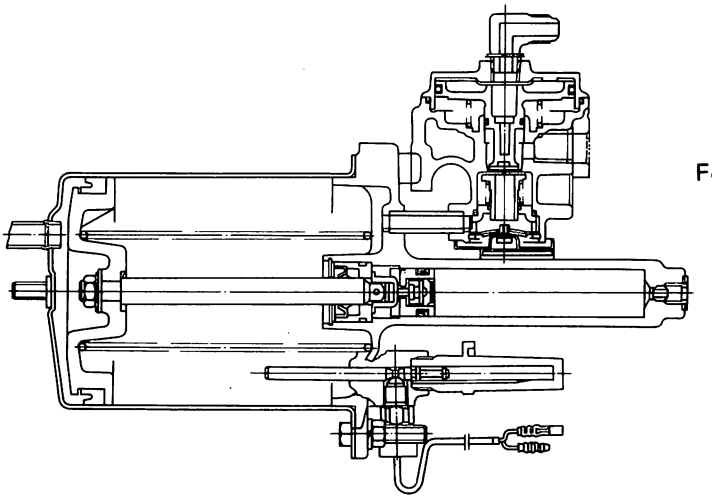
(1) Power cylinder, power piston
(2) Relay valve
(3) Hydraulic cylidner, hydraulic piston
(4) Cylinder plug



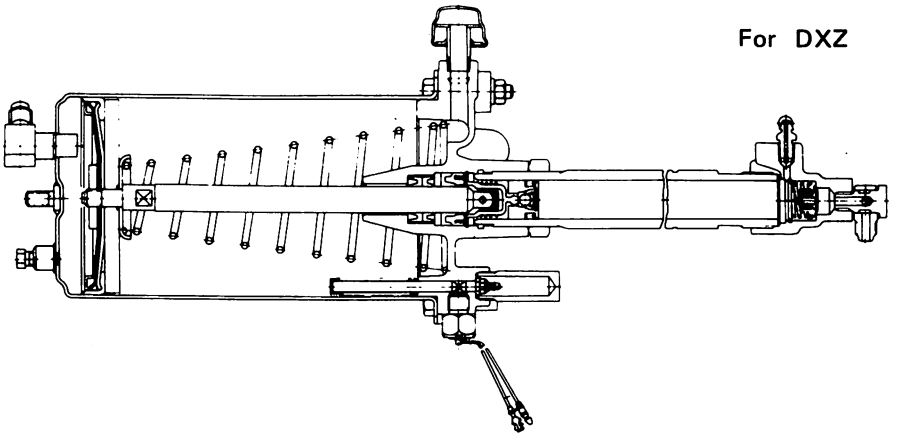
AIR PRESSURE OPERATED MASTER CYLINDER (AIRMASTER)

Type	Servo Cylinder Dia. (mm)	Hydraulic Cylinder		Applicable Model
		Dia. (mm) (Front/Rear)	Stroke (mm) (Front/Rear)	
AirMaster Dual	114.3	23.8/23.8	79/79	FSR, MR1
	138	29.1/29.1	118/158	DXZ
			118/118	CVR, C-R, FTR, FTS





For CVR



For DXZ

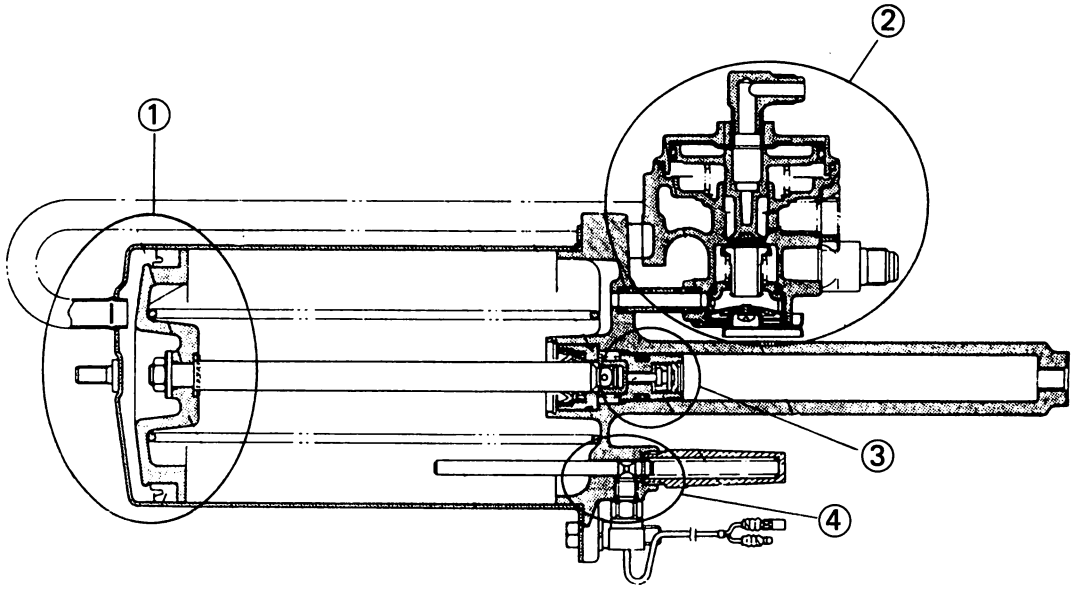
Air over hydraulic servo type

Construction

The air over hydraulic servo type consists basically of the following 5 major components:

The main components include:

1. Power cylinder, power piston.
2. Air relay valve.
3. 9 Hydrualic cylinder,, hydraulic piston.
4. Brake lining wear indicator light.



(1) Air master structure

There are two air masters, one for the front and rear back axle and another for the rear front axle. (They are used to generate high oil pressure by supplying the pressure of the compressed air from the air tank to a power cylinder).

The air master consists of a relay valve whose function is to send the pressure of the compressed air to the power cylinder according to the control pressure sent from the brake valve, a power piston for activating the hydraulic piston, a hydraulic piston for generating oil pressure and sending it to the wheel cylinders, and an indicator rod for activating the brake warning light.

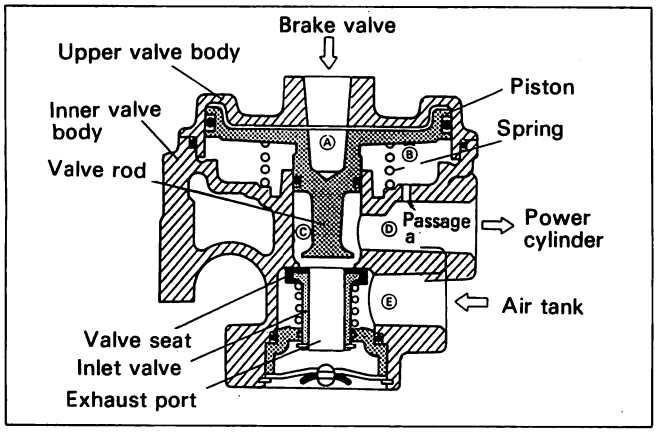
NOTE: For Z vehicles, there is one air master for the front and rear front axle, another for the rear back axle.

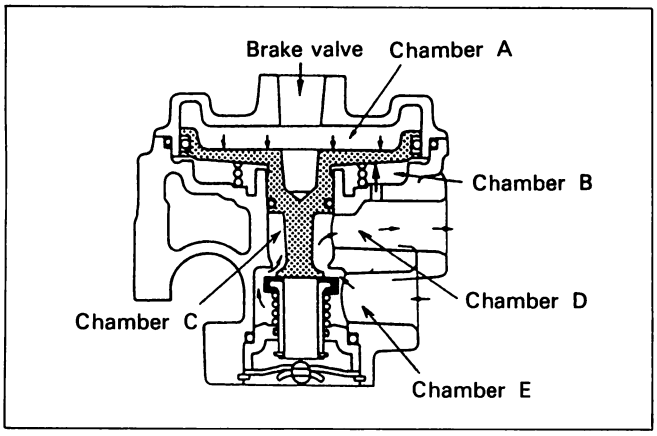
For FRR vehicles, the control pressure sent from the dual brake valve acts directly on the air master's power cylinder.

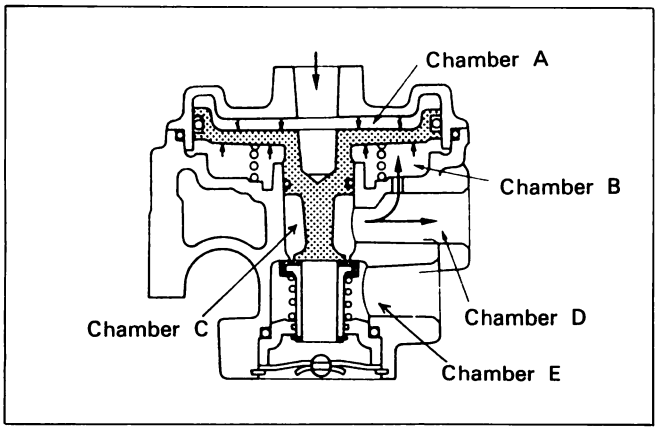
Air Master Operation

(1) Operation of air master relay valve

The relay valve, shown in the diagram below, consists of control chamber Ⓐ which receives the control pressure from the brake valve, an upper valve body, an inner valve body, a piston assembly which generates a pressure equal to the pressure in control chamber Ⓐ, and a valve seal which seals in the compressed air from the air tank, etc.







(1) When not activated

When not activated, control chamber Ⓐ is released to the atmosphere via the brake valve, and the piston assembly is set to the stop position by the action of the spring. Chambers Ⓑ, Ⓒ and Ⓓ are connected to the exhaust port and released to the atmosphere. Chamber Ⓔ is connected to the air tank and kept air-tight by the inner valve body's seal and the valve seat.

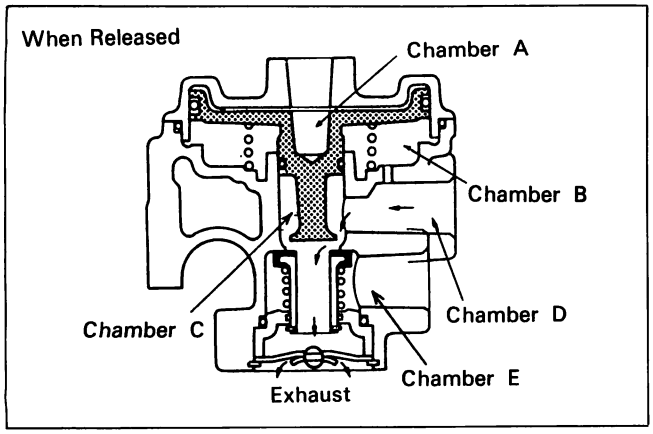
Diagram: Brake valve

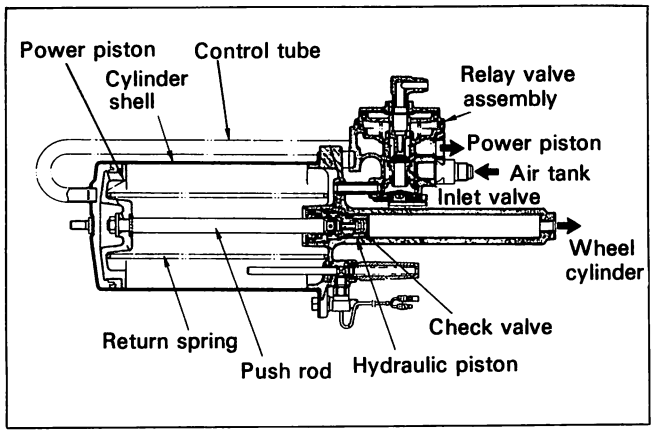
(2) When activated

When the compressed air's control pressure enters control chamber Ⓐ from the brake valve, the piston is activated, the spring is compressed, the tip of the valve rod comes into contact with the valve seat, the exhaust port and chambers Ⓒ and Ⓓ are closed, and the valve seat is pressed open, connecting chambers Ⓓ and Ⓔ. (Operation start point)

Thus, the compressed air flows into chamber Ⓓ from chamber Ⓔ, is sent from chamber Ⓓ to the power cylinder, and generates braking power. At the same time, the compressed air passes through the passage opened in the inner valve body into chamber Ⓑ. After the start of operation, chambers Ⓓ and Ⓔ are connected until the pressure of the compressed air in chambers Ⓐ and Ⓑ is balanced, at which point the tip of the valve rod, which is seated on the valve seat, moves upward, the inner valve body and valve seat shut off chambers Ⓓ and Ⓔ, and the pressure of the compressed air in chamber Ⓑ remains stable. When the control pressure in chamber Ⓐ increases further, the valve rod is moved downward, the inner valve body and valve seat are opened, the compressed air flows into chambers Ⓓ and Ⓑ, and when the pressure of the compressed air is the same as in chamber Ⓐ, the inner valve body and valve seat are once again seated.

Thus, with this structure the pressure in chambers Ⓐ and Ⓑ is always balanced.





(3) When released

When the brake valve is released, control chamber Ⓐ is released to the atmosphere. If the pressure in chamber Ⓑ is greater than that in chamber Ⓐ, it acts on the piston, the valve rod is pressed upward from the balanced position, the valve seat and valve rod seat are opened, chamber Ⓓ and the exhaust port are connected, the compressed air in chamber Ⓓ is released into the atmosphere, and the brake is released.

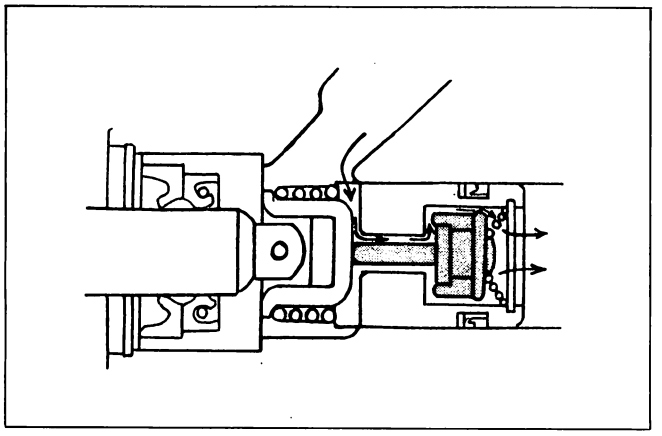
(2) Operation of power cylinder and power piston

The power cylinder receives the compressed air pressure sent from the brake tank through the operation of the brake valve and transmits the total pressure to the hydraulic section. It consists of a power piston, return spring, push rod, and cylinder shell, etc.

The power piston and return spring are inside the cylinder shell. The compressed air pressure from the air tank acts on the cylinder chamber to the left of the power piston, with the cylinder chamber on the right directly connected to the atmosphere.Ⓐ piston packing is installed on the surface of the power piston, sealing off the compressed air in the power chamber from the atmosphere side. In addition, a push rod is also installed on the power piston to transmit the movement (force) of the power piston to the hydraulic section.

(3) Hydraulic cylinder and hydraulic piston

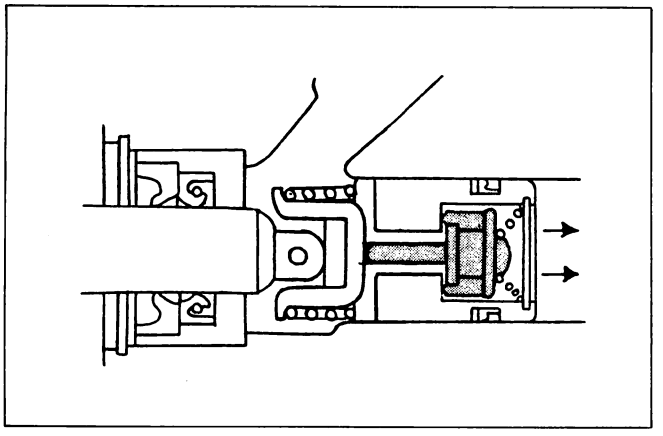
These parts change the air pressure (total pressure) generated by the power cylinder into hydraulic pressure via the push rod and transmit this force to the wheel cylinder. The Hydraulic cylinder includes a hydraulic piston assembly linked to one end of the push rod, and this assembly includes a check valve. The sliding part of the push rod maintains oil- tightness using an oil seal and cup. The brake fluid from the oil tank enters through the oil hole in the end plate, the hydraulic cylinder's oil chamber is connected through the hole in the center of the piston, and its tip is in turn connected to the wheel cylinder. (When the power piston begins to operate, the check valve closes, and the brake fluid in the cylinder is sent to the wheel cylinder.)



(Before operation)

The diagram at the left shows the air master before operation.

Both ends of the power piston are at atmospheric pressure, so the power piston is pushed to the left side of the cylinder shell by the return spring. Also, the hydraulic piston assembly is pulled to the left by the movement of the push rod linked to the power piston, and the yoke fixed in the hydraulic piston assembly comes into contact with the stop washer, moving the check valve's ball away from the hydraulic piston assembly's seat, so brake fluid can flow freely from the hole in the center of the piston into the hydraulic cylinder.



(When operating)

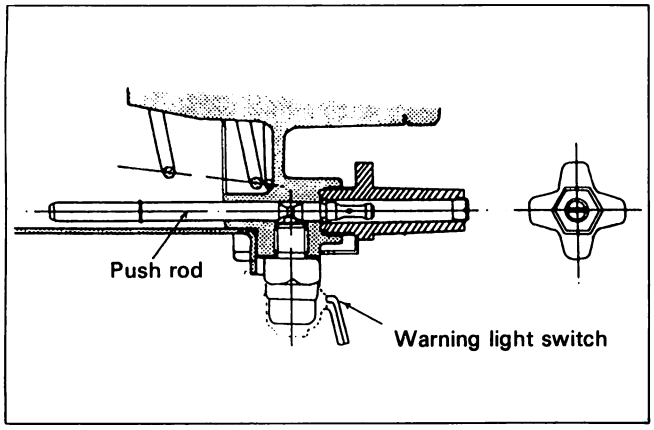
When the brake pedal is pressed, the compressed air from the relay valve enters the power cylinder, the power piston overcomes the force of the return spring and moves to the right, and the yoke at tip of the push rod moves away from the stop washer. The check valve is seated on the hydraulic piston assembly's seat, and the oil chamber on the oil tank side and the oil chamber on the hydraulic cylinder side are isolated one from the other.

Air pressure when operation starts: 0.55kg/cm^2

When the pressure of the compressed air reaches above 0.55kg/cm^2, the power piston and hydraulic piston are pressed further to the right, the brake fluid in the hydraulic cylinder is pressurized, and the hydraulic pressure is transmitted to the wheel cylinder.

(When released)

When the brake pedal is released, the chamber on the left side of the power piston returns to atmospheric pressure, so the power piston and hydraulic piston are pulled back to the position before operation by the return spring and the hydraulic pressure of the hydraulic cylinder, and the brake is released.



(4) Brake warning light (lining wear detector)

When the brake is operating, the air master's power piston stroke is detected, and if the gap between the brake lining and drum is large or if the brake's hydraulic system is damaged and oil is leaking, the warning lamp on the dashboard in the driver's compartment lights to warn the driver if the wear indicator (lining wear detector) in the air master is activated. If the brake system is normal, the rod in the lining wear detector is at the position shown in the diagram and the switch is in the cut part of the rod and off.

If for some reason the power piston's stroke is large, the bottom of the power piston presses the tip of the rod, the switch moves out of the cut part of the rod and turns on, and the brake warning light in the driver's compartment lights to warn the driver of danger.

(Once this light turns on, the relay is activated and the light remains on even if the brake pedal is not pressed. Thus, it remains on until the battery's relay switch is turned off.)

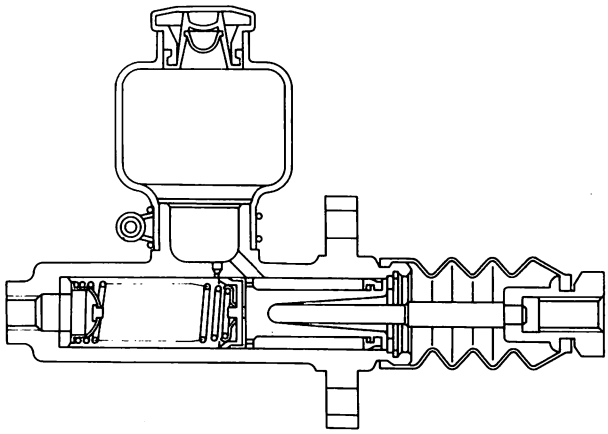
If the brake warning light turns on, inspect and adjust the brake system immediately, then before driving check that the light remains off when the brake pedal is pressed.

Master cylinder

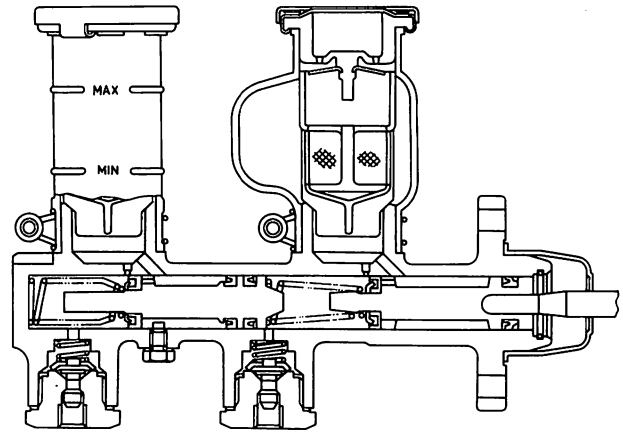
Outline of master cylinder

The master cylinder has a function of generating fluid pressure by converting the depression force applies to the brake pedal, and can also easily fill the brake system with brake fluid and give pressure increase or decrease response to varying pedal depressing forces.
The master cylinder comes roughly in two kinds depending on the number of pressure chambers.
Single master cylinder and tandem master cylinder.
The tandem master cylinder has an additional hydraulic chamber as compared with the single type, but is basically the same in operation as the single master cylinder.
Most of the vehicles now have the tandem master cylinder.

Single

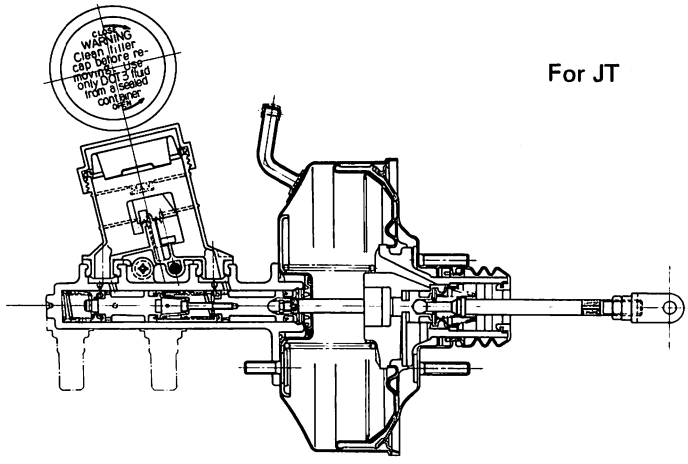


Tandem

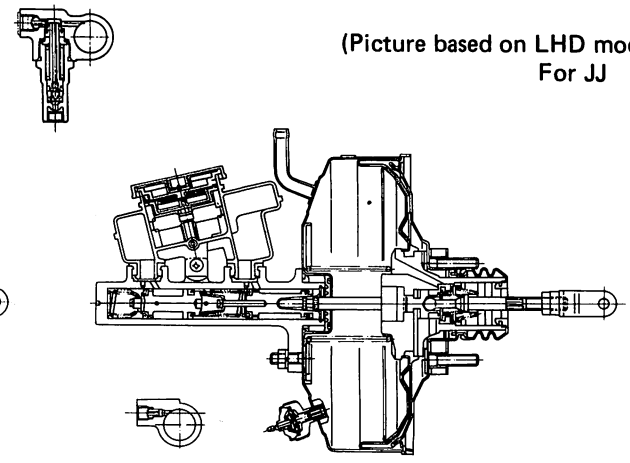


MASTER CYLINDER WITH VACUUM SERVO
(Passenger car, pickup & wagon)

Type	Master Cylinder			Vacuum Cylinder		Applicable Model
	Inside Dia. (mm)	Stroke (mm)		Inside Dia.	Stroke	
		Front	Rear	(mm)	(mm)	
Tandem master integrated servo	20.64	15	16	180	32	JT
	22.2	15	16	205	32	JJ
		18.7	13	205	32.5	JR, KB
	23.81	18	13	230	32	UBS



For JT

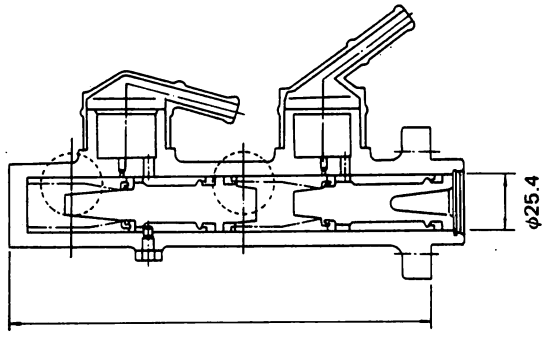


(Picture based on LHD model)
For JJ

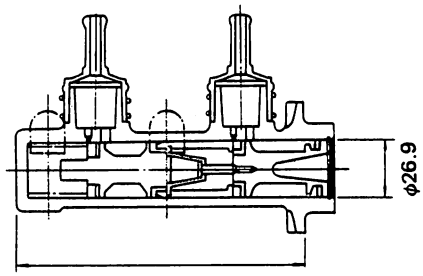
The master cylinder diameter has been increased from ϕ 25.4 to 26.9 mm to reduce the stroke of the brake pedal and to improve braking performance.

(NKR)

Conventional

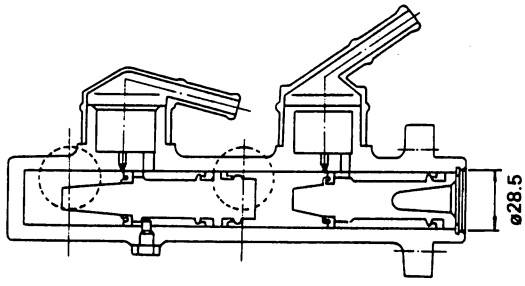


New



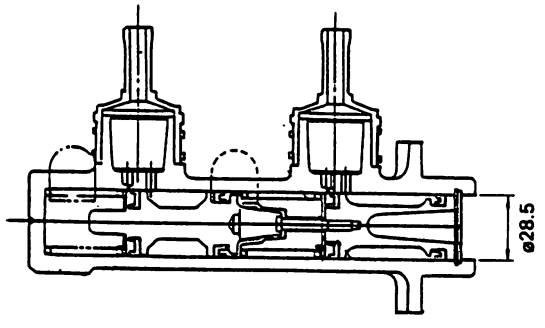
(NPR)

Conventional



Cylinder Material : Cast iron

New



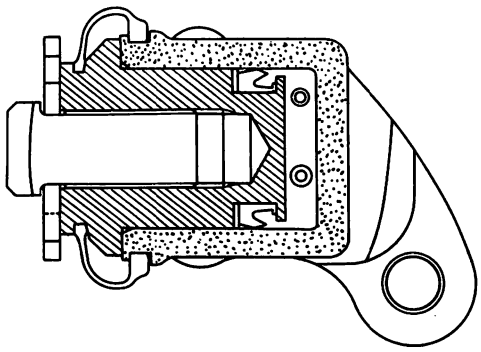
Cylinder Material : Aluminum

Wheel cylinder

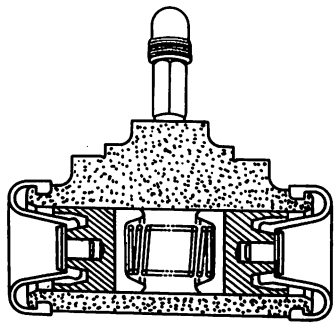
Outline of wheel cylinder

The wheel cylinder is mounted on the brake drum cover, and receives the pressure fed by the master cylinder t expand the brake shoes via the piston and push rod. The wheel cylinder comes in two types, that is, a single piston type and an opposed piston type.

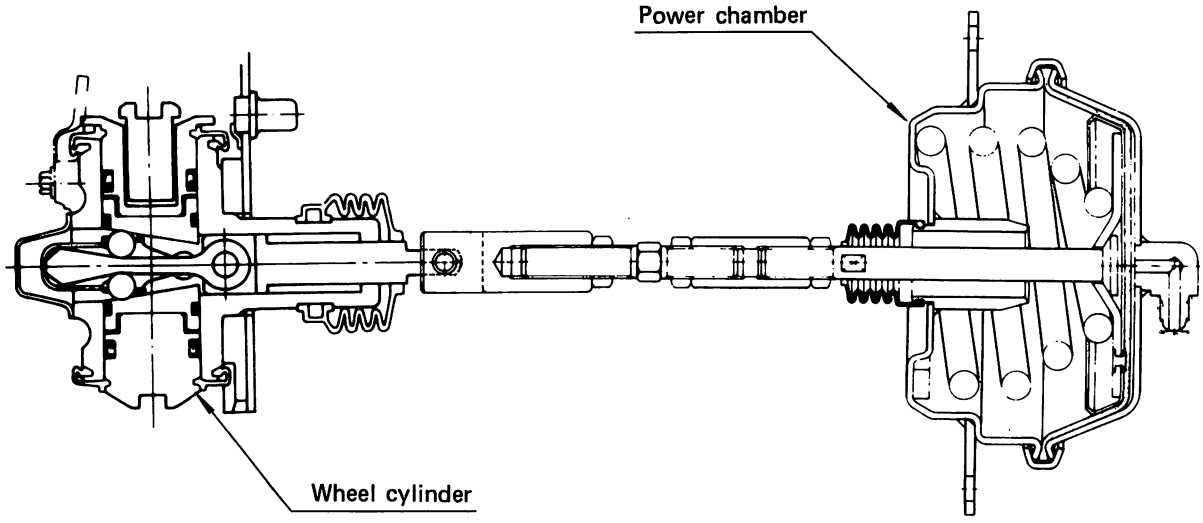
Single type

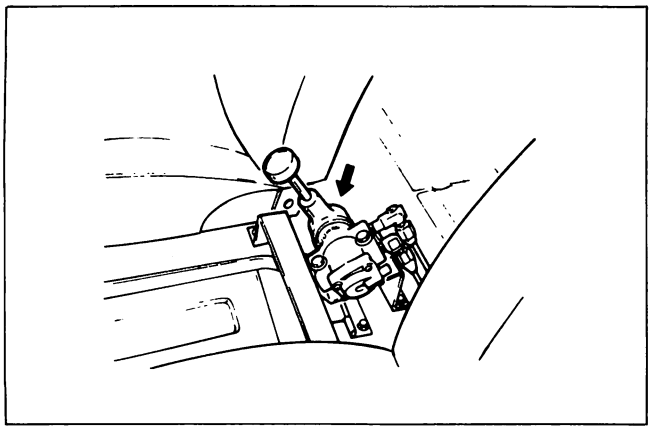


Opposed type



For wheel parking brake

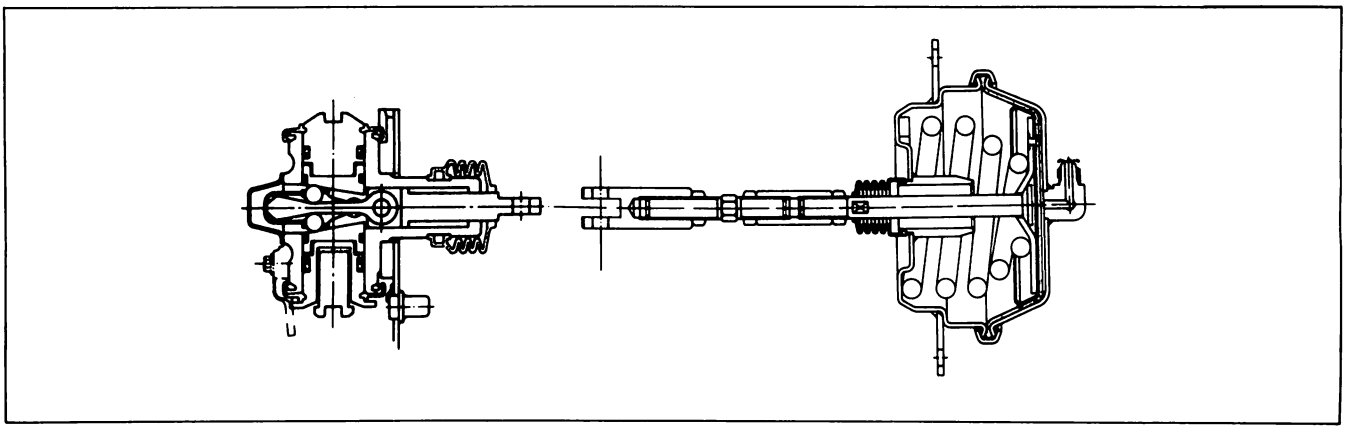




Wheel parking brake

Incase of the emergency

If the air pressure in the air tank is lowered, the spring brake can not be released with the brake valve. In such instance, the spring brake can be released as follows.



Release of Wheel Parking Brake For Emergencies and Restoration

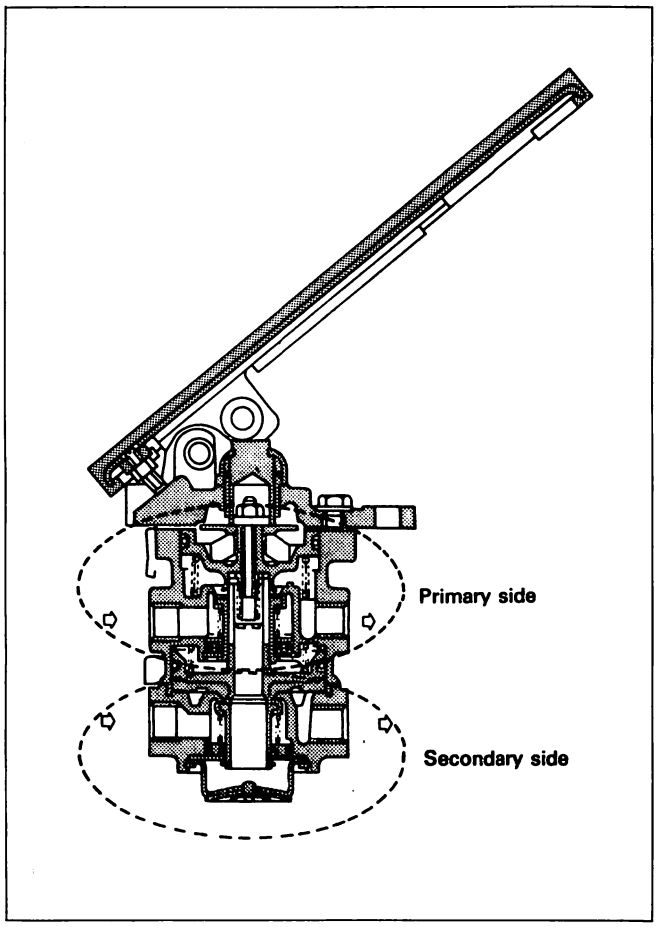
Release

Rotate the turn buckle of the push rod which connects the wheel cylinder and power chamber to extend the rod until the wheel rotates freely.

Restoration

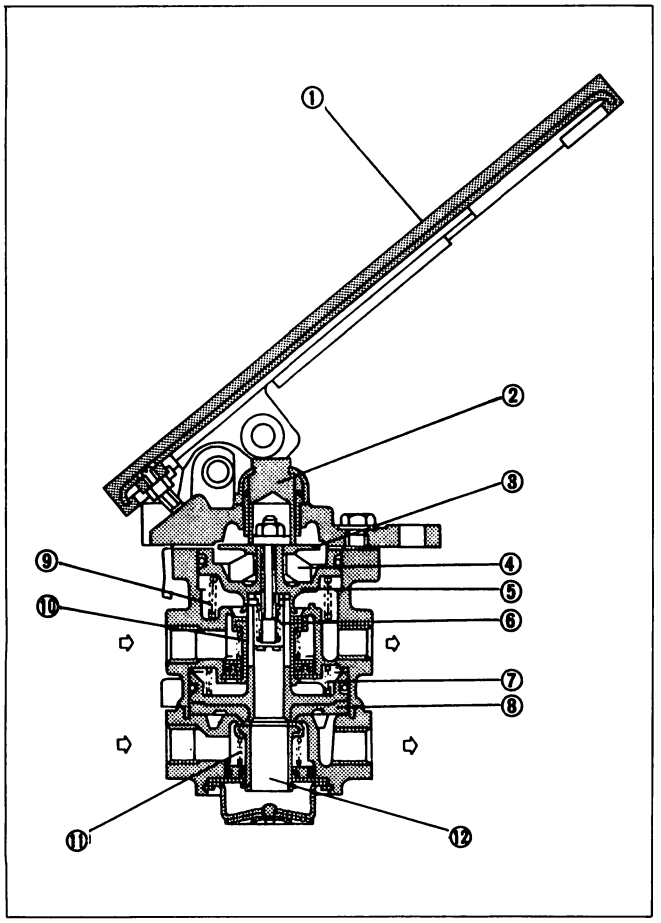
1. Remove the pin from the jaw joint and detach the push rod.
2. Fill the power chamber with air of the specified pressure.
3. Pull the rod on the wheel cylinder side outward by hand, rotate the turn buckle to shorten the push rod to the proper length, attach the jaw joint and insert the pin.

NOTE: The wheel cylinder will be damaged if the air chamber is filled before the push rod is detached.



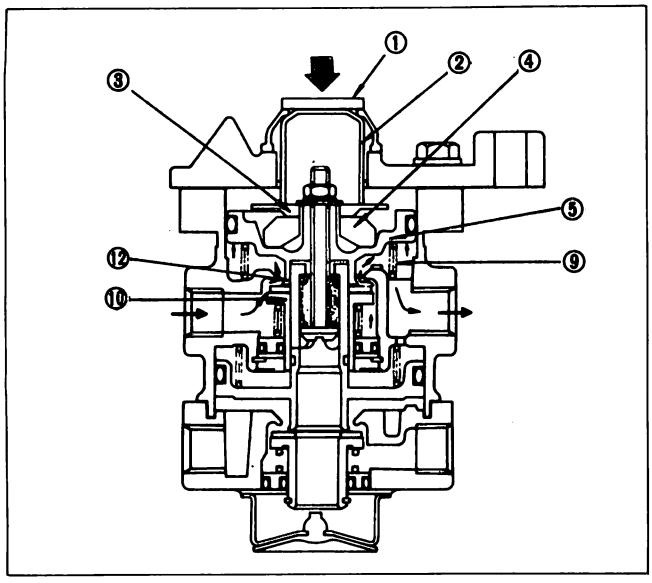
Dual brake valve

The dual brake valve is a control valve which operates as the pedal is depressed by the floot, and supplies an air pressure corresponding to the depressed angle of the pedal to the relay valve.
The dual brake valve consists of two control valves, primary and secondary each of which has an air supply port for supplying the air from the air tank, and a discharge port for sending the air to the relay valve.
The dual brake valve independently controls the two separate brake circuits (primary and secondary) so tha, even if one of the brake circuits should fail, the other circuit can apply the brake, and thus ensure the safety of the vehicle.



Construction

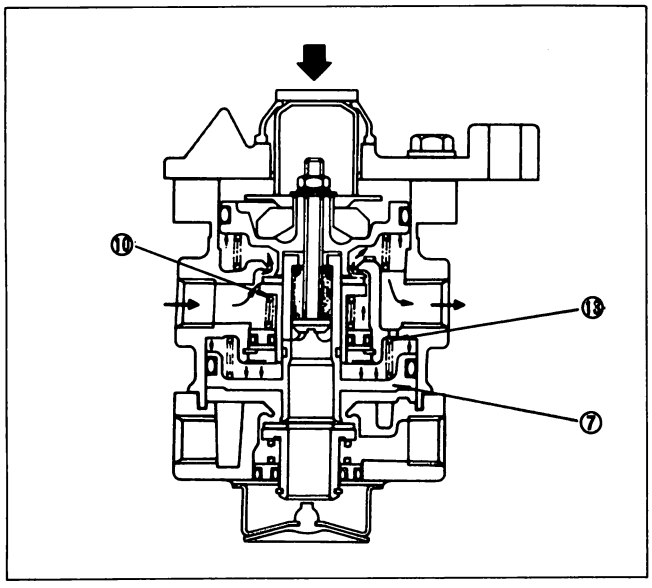
The pedal ① is mounted on top of the brake valve in contact with the plunger ② for the primary valve. The normal control madel has a linkage between the brake valve and pedal. The plunger ② is in contact with a spring seat ③, to which a rubber spring ④, primary piston ⑤, stem spring ⑥, relay piston ⑦, and relay piston spring ⑧ are fitted together.
The primary piston ⑤ is kept pushed upward by a return spring ⑨.
The primary valve assembly ⑩ is mounted under the primary piston ⑤.
The secondary valve has the same construction as the primary valve, and is pushed to the body seat by a spring ⑪. Each valve and each relay piston ⑦ are hollow, and the discharged air runs through their hollow centers to push up the exhaust passage ⑫ located at the bottom end to the exhaust port, and out into the atmosphere.



Normal operation

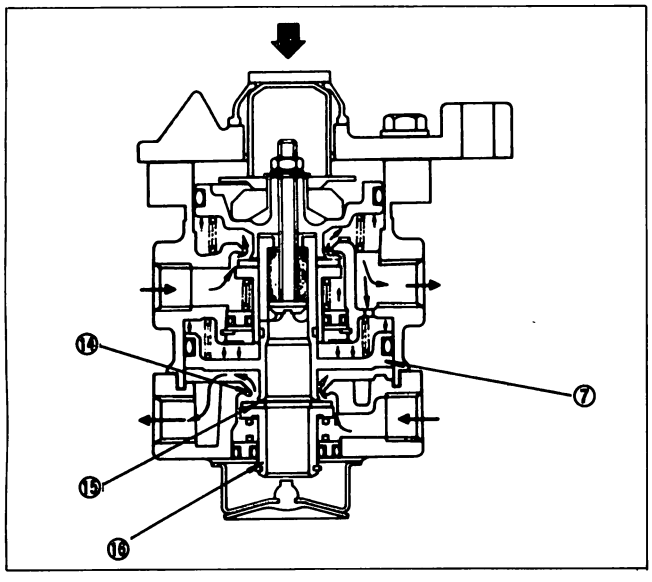
When dual brake valve is depressed.

When the pedal ① is stepped on, the foot's depressing force is conveyed via the plunger ②, spring seat ③, and rubber spring ④ to the piston ⑤ so that the piston compresses the return spring ⑨ and moves downward. As the piston ⑤ goes down, the primary exhaust valve seat ⑫ at the bottom end of the piston ⑤ contacts the primary inlet vlalve ⑩ to close the center exhaust passage.



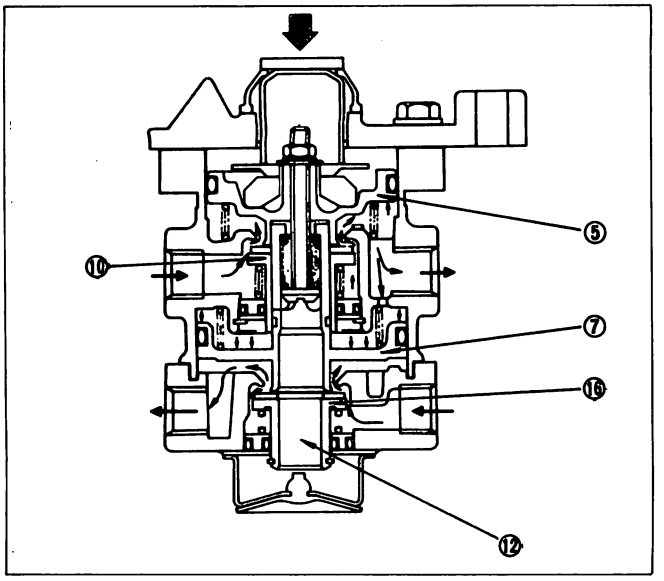
The piston further compresses the primary valve return spring ④ so that the primary valve opens to let air out of the supply port to the discharge port, from which the air is supplied to the primary system relay valve as a command pressure.

When the primary valve ⑩ operates, a part of air pressure is routed through hole ⑬ of the body to chamber in the top part of the secondary valve relay piston ⑦ to push the relay piston down.



The secondary exhaust vlave seat ⑮ of the bottom end of the relay piston ⑦ contacts the secondary inlet valve ⑯ to close the center exhaust passage.

The secondary inlet valve ⑯ is further pushed downward to make a clearance between it and the body inlet valve seat ⑭ so that the air from the supply port runs to the secondary discharge port, from which the air is supplied to the secondary system relay valve as a command pressure.

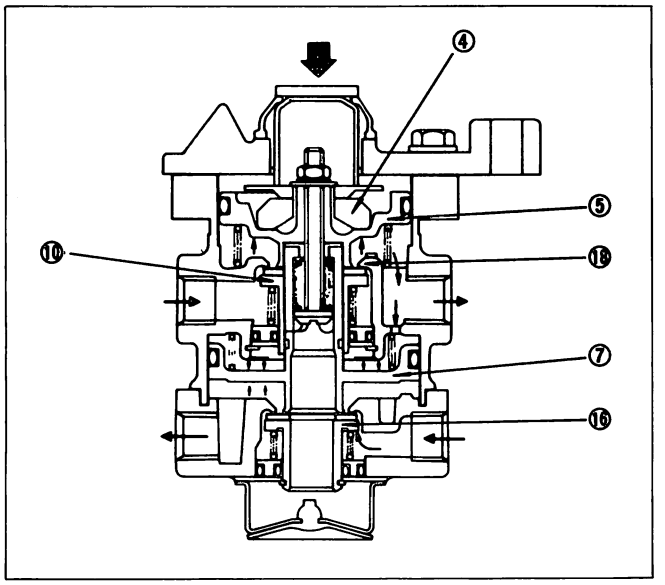


Balancing

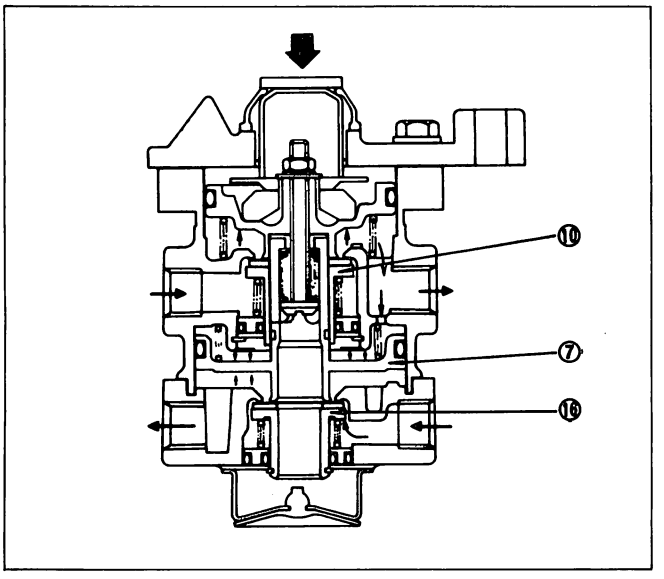
When a depressed angle is kept constant the air pressure generated by depressing the pedal is stabilized at a level corresponding to the depressed angle.

When the pedal is stepped on, the exhaust passage ⑫ closes and the inlet vlave ⑩, ⑯ open to start air supply as mentioned above.

The air pressure simultanelusly works on the bottom of the piston ⑤, ⑦ to push it up.

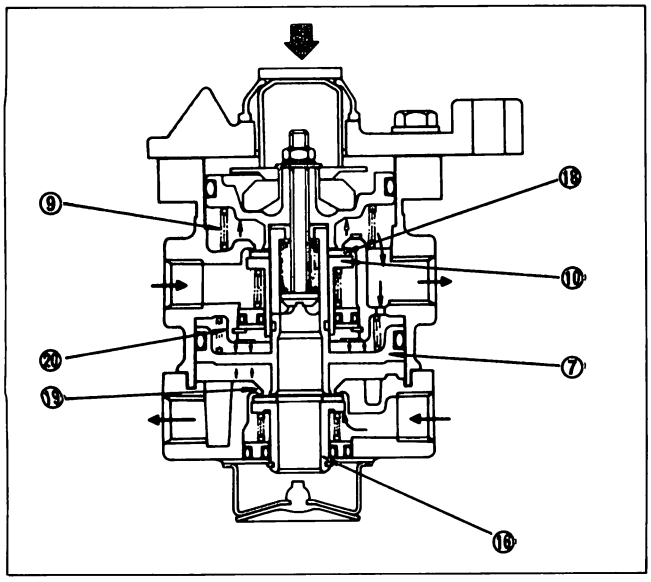


If the pedal depressing angle is kept constant, the air pressure on the bottom of the pistons ⑤, ⑦ raises the piston to compress the rubber spring 4 on top of the piston ⑤, ⑦. The piston ⑤ rises in contact with the inlet valve ⑩, ⑯ and the inlet valve contacts with the body inlet valve seat ⑱ to stop the air supply. The piston ⑤ and inlet valve ⑩ are in contact with each other, and the air pressure stabilizes at this point of time.

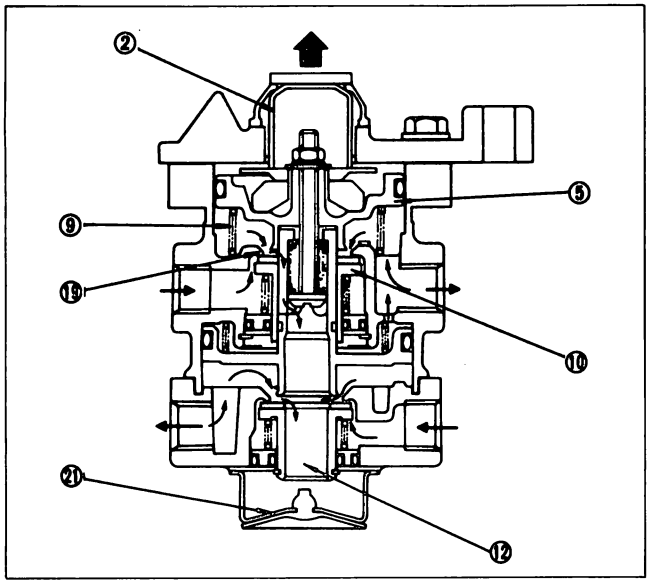


The secondary relay piston ⑦ falls according to the air pressure supplied from the primary inlet valve ⑩, the generating an air pressure in the secondary inlet valve ⑯. This air pressure simultaneously acts on the bottom of the relay piston ⑦.

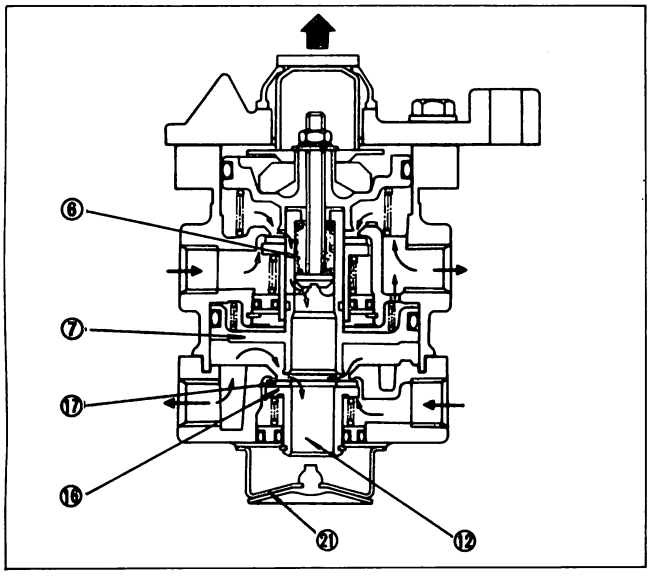
When the seconday pressure acting on the bottom of the relay piston ⑦ becomes equal to the primary pressure applied to the top of the piston ⑦ down is offset so that the relay piston ⑦ moves upward in contact with the secondary inlet valve ⑯



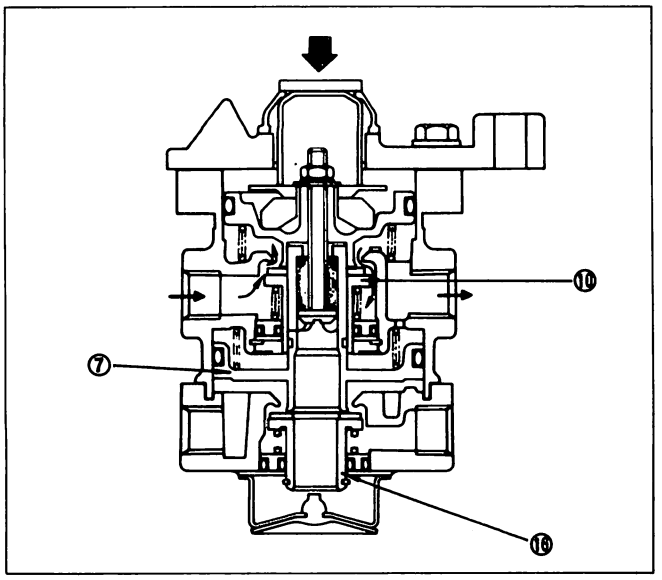
When the inlet valves ③, ⑯ contact cover's inlet valve seats ⑱, ⑲, air supply from the supply port to the discharge port is stopped. Because the exhaust ports is closed at this time, the air pressure stabilizes without rising. At this point of time, the secondary air pressure stabilizes at the same level as the primary air pressure.
The relay piston spring ⑨, ⑳ plays the role of reducing pressure difference between the primary inlet valve ⑩ and secondary inlet valve ⑯.



When dual brake valve is released
When the pedal is released, the plunger ② and piston ⑤ are pushed up by the spring ⑨ and the primary valve air pressure so that the exhaust vlave seat ⑲ at the bottom end of the piston 5 moves from the primary inlet valve ⑩, thus opening the center exhaust passage ⑫.
The primary valve ⑩ air pressure released through the exhaust passage ⑫ and exhaust port ⑳ into the atmosphere.



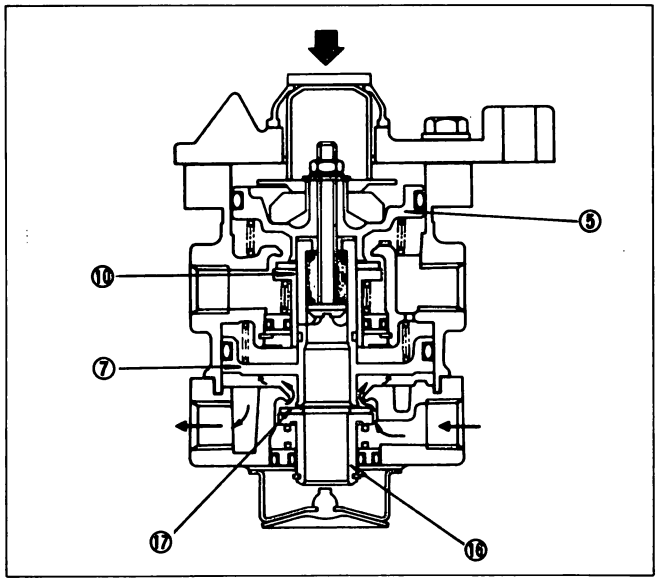
If the primary air pressure falls, the relay piston ⑦ is pulled up by the secondary air pressure and the stem spring ⑥ so that the exhaust vlave seat ⑰ at the bottom end of the relay piston ⑦ moves away from the secondary inlet vlave ⑯, thus opening the center exhaust passage ⑫ to the atmosphere.
Therefore, the secondary air pressure is released through the exhaust passage ⑫ and exhaust port ⑪ into the atmosphere.



Operation in case of pipe breakage

Operation of primary valve only

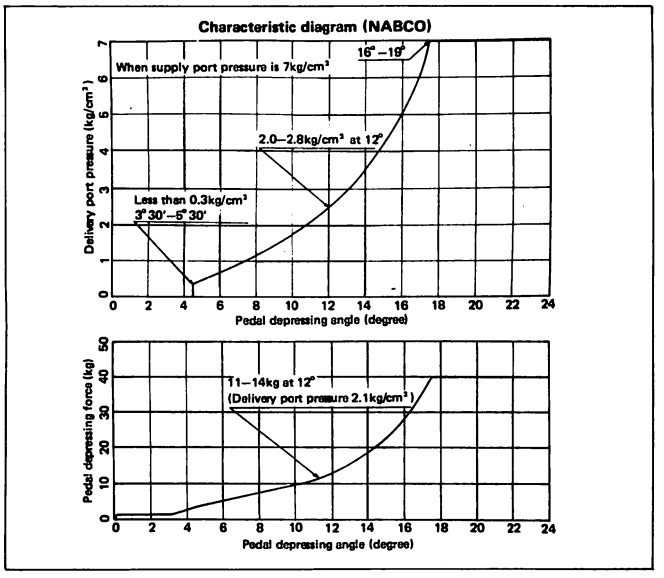
If the secondary brake piping is damaged, the primary valve ⑩ operates normally because it is separated from the secondoary valve ⑯ by the relay piston ⑦



Operation of secondary valve only

If the primary brake piping is damaged, no primary air pressure is generated to operate the relay piston ⑦ and the secondary valve ⑯ as in normal operation.

If the pedal is depressed further than normal, the bottom end of the piston ⑤ hits the top of the relay piston ⑦ so that the relay piston exhaust valve seat ⑯ directly pushes the inlet valve ⑯ to generates an air pressure, stabilizes it, and releases it in the same way as in the primary valve ⑩ in normal condition.



Dual brake valve performance

This performance curve shows the pedal depressing force and the deliviery port pressure when the dual brake valve pedal is drepressed. When judging a dual brake valve, check that it satisfied the performance curve, and check the following three points:

(1) Pedal play
(2) Delivery port pressure and pedal degressing force at a depressed angle of 12°
(3) Maximum delivery port pressure

SECTION 4

BRAKE SAFETY DEVICE

Outline of safery device

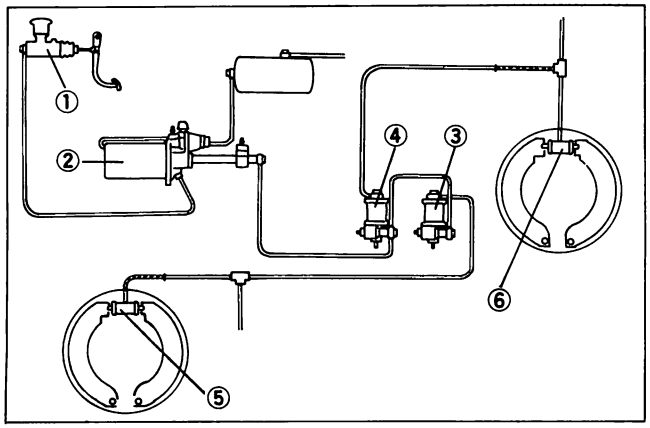
Brake system failures can never be tolerated so sufficient care is exercised to assure the required quality standards of the individual parts. To assure added safety, various kinds of safety devices are employed as classified below.

1. Dual brake system to prevent the danger of total loss of braking.
2. Alarms for preventive safety.
3. Fluid pressure regulating valve for improved stability of braking operation.

Some of the safety devices mentioned in Items 1 and 2 are required by law in Japan, Europe, and the United States. Item 3 is not required by law, but is used on many vehicles to satisfy the braking requirements.

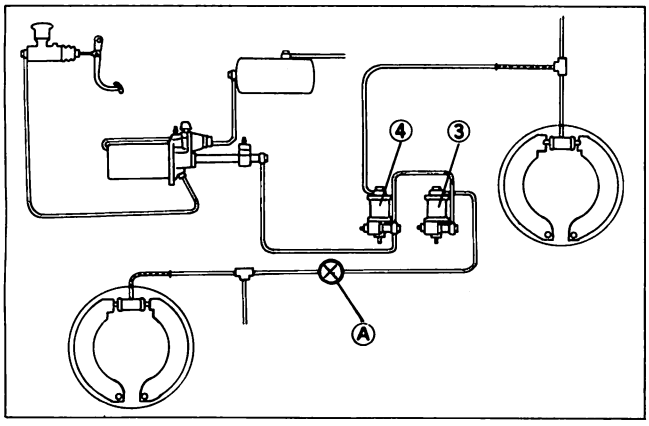
Dual brake system

The dual brake system consists of two separate brake systems, one for the front wheels and the other for the rear wheels, for example. Even if the piping of one of the two systems is damaged and goes out of use, the remaining system providing a certain degree of braking power.
The dual brake system now in use comes in two types: One uses safety cylinders mounted in the brake piping to divide the piping into two, and the other consists of completely separated two systems.
The former is called the single circuit with safety cylinders, and the latter the complete dual circuit.

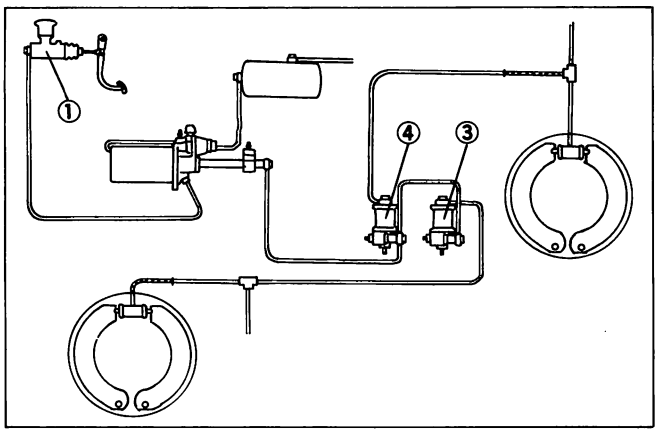


Single circuit with safety cylinders

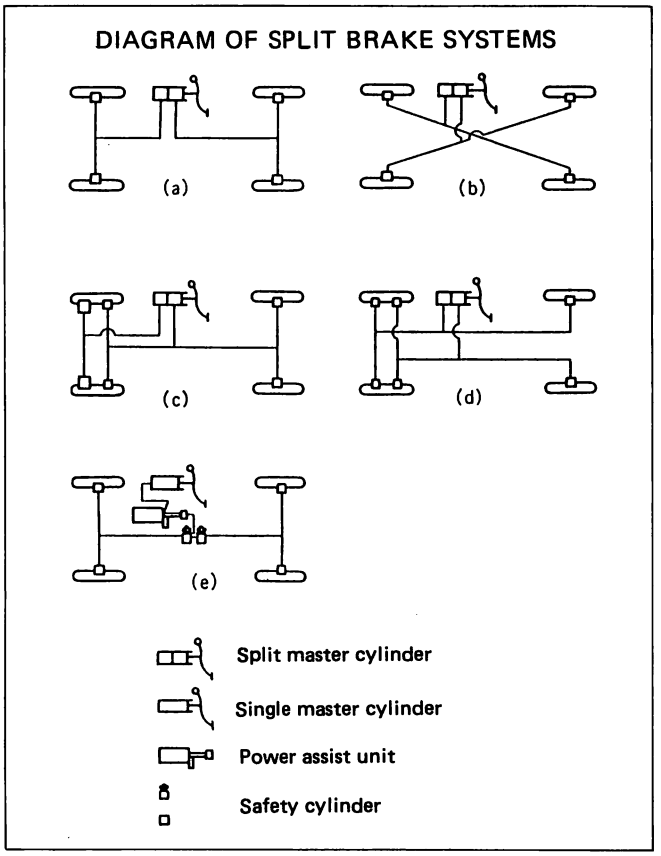
The hydraulic pressure from the master cylinder ① in creased to a higher pressure by the booster ② reaches the wheel cylinders ⑤ and ⑥ via the safety cylinders ③ and ④ to actuate the shoes.



The safety cylinders ③ and ④ are privided for independent operation of the brake system divided into two parts in the piping.
If the front wheel brake piping, for example, breaks down a Point Ⓐ and bleeds the brake fluids from there, further leakage can be prevented by closing the valve for the safety cylinder ③, there by permitting the rear wheel brake to properly operate to bring the vehicle to a safe stop and prevent accidents.
(For further details, refer to the paragraph for the safety cylinders.)



It must be borne in mind, however, that if the brake fluid leaks due to damage between the master cylinder ① and the safety cylinders ③, ④, the braking force will be totally lost.



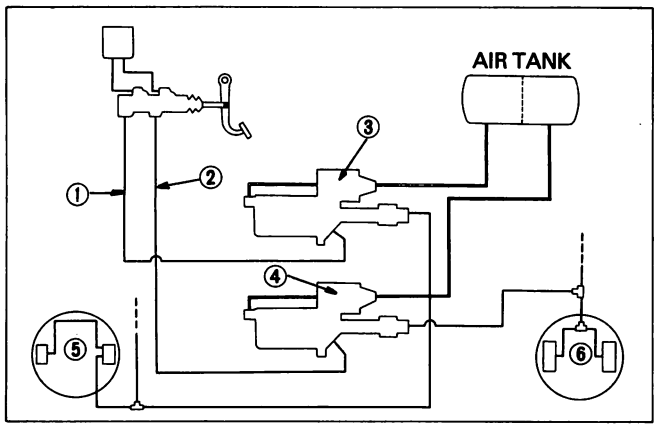
Dual circuit

Different from the single circuit, the dual circuit consists of completely independent brake systems from the master cylinders to the wheel cylinders.

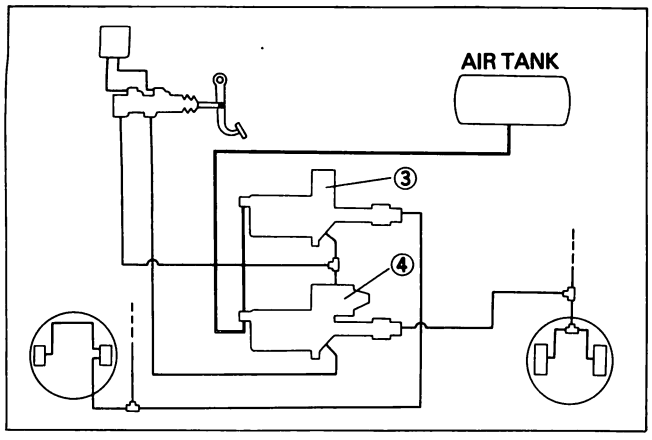
Most vehicles use a simple network of pipes and tubing to deliver hydraulic fluid to the front and rear axle brakes.

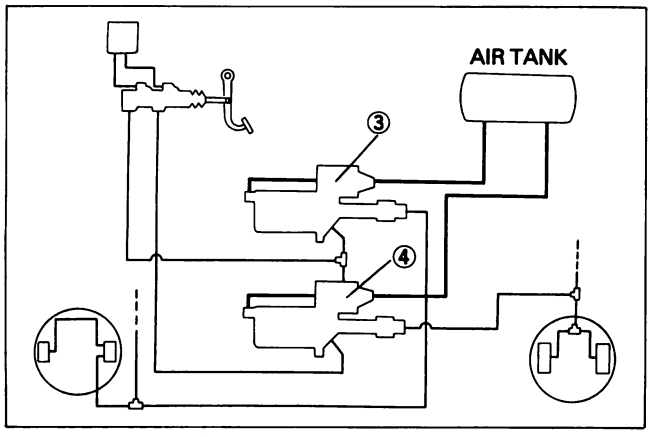
Front-wheel-drive vehicles require more braking power at the front wheels than at the rear. The split brake system is used to deliver this greater braking power to the front wheels.

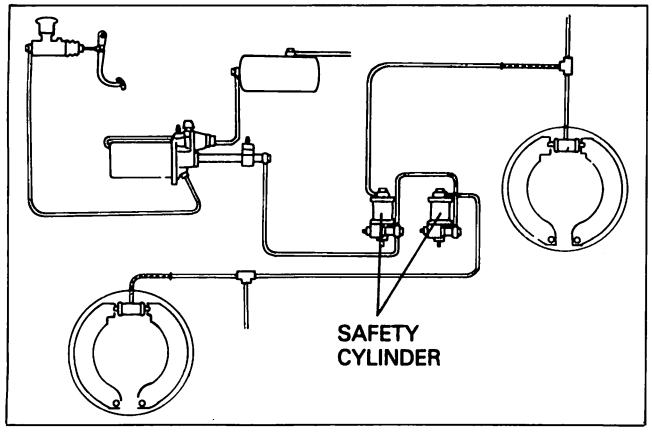
In the event of damage to the front wheel brakes, overall braking power is greatly reduced. To prevent this severe reduction in braking power, many four-wheel-drive vehicles use the diagonal split brake system shown in Figure (b).

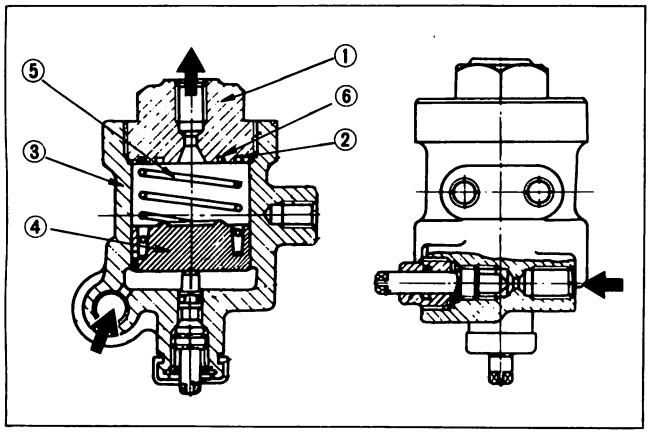


The hydraulic pressure from the tendem master cylinders ① and ② increased to a higher pressure by the boosters ③ and ④ reaches the wheel cylinders ⑤ and ⑥ to actuate the respective shoes.









The dual circuit comes in the following two types apart from the above-mentioned dual piping configuration.

1. A relief valve is provided for either one of the two boosters ③, ④ and a signal hydraulic pressure is fed to the relief valve from thelrespective chambers of the tandem master cylinders so that even if one of the two pipings fails, both booster power piston operate in braking.

2. Relief valves are provided for both boosters ③, 4 and the signal hydraulic pressures of the two pipings are fed to either one of the relief vlaves. Even if one of the two pipings fails, both boosters, ③, ④ operate under a certain condition.

Safety cylinder

Outline of safety cylinder

To maintain brake function in the event of a hydraulic circuit failure, a pair of safety cylinder for the the front and rear hydraulic circuits are installed in the pipe line behind the brake booster, so that either the front or the rear brake hydaulic circuit is made to work normally by pumping the brake pedal even when a leaky condition is encountered due to following reasons.

- ○ Damage to brake pipe or brake hose
- ○ Damage to brake hydraulic circuit caused by an external force
- ○ Worn or damaged wheel cylinder or piston cups

Construction

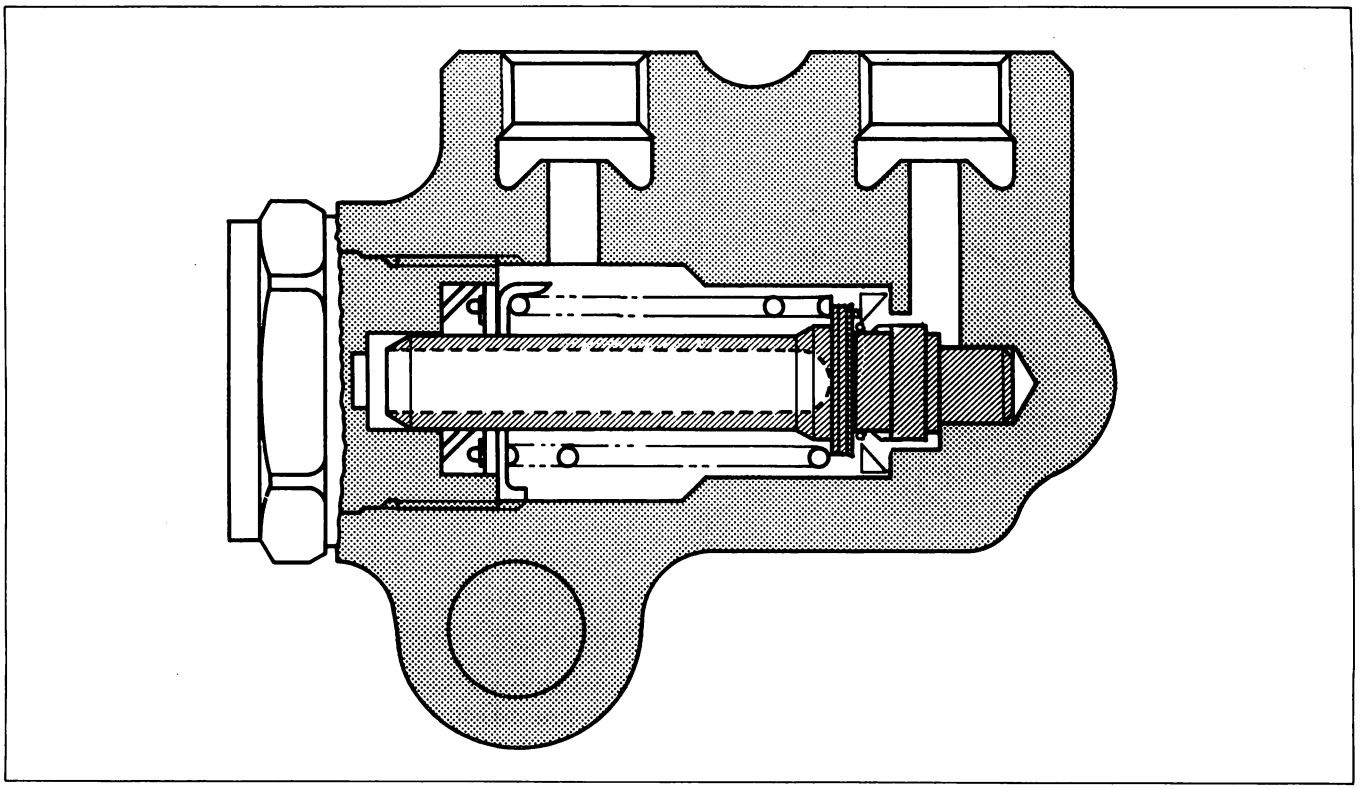
The cylinder cup ① with a port for feeding brake fluid into the wheel cylinder is installed, via the gasket ② to the cylinder ③.
The piston ④ with a assage and oil port for feeding brake fluid to the wheel cylinder is fitted into the cylinder ③ together with the return spring ⑤.
The cylinder cap ① facing the piston ④ is fitted with stopper ⑥ made of special light alloy.
The parts are so arranged that if a leakage has developed in the wheel cylinder side, the piston is raised by the presure of brake fluid fed from the master cylinder, until it is end is seated against the metalic stopper, to prevent further fluid leakage.

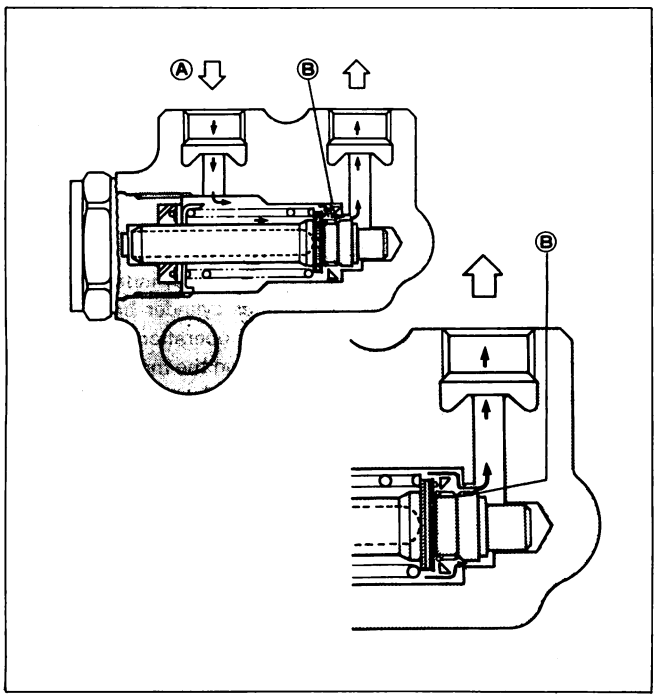
[ANTILOCK DEVICE]

• Pressure control valve (P.C.V.)

Outline of P.C.V.

When the brake hydraulic pressure exceeds a specific level in braking, the P.C.V. controls the hydraulic pressure to the rear wheel brake to make the rear wheel hydraulic pressure smaller than the input hydraulic pressure by a specific percentage, thus assuring the most efficient operation of the rear wheel brake. This provides steady braking power without early locking of the rear wheels.

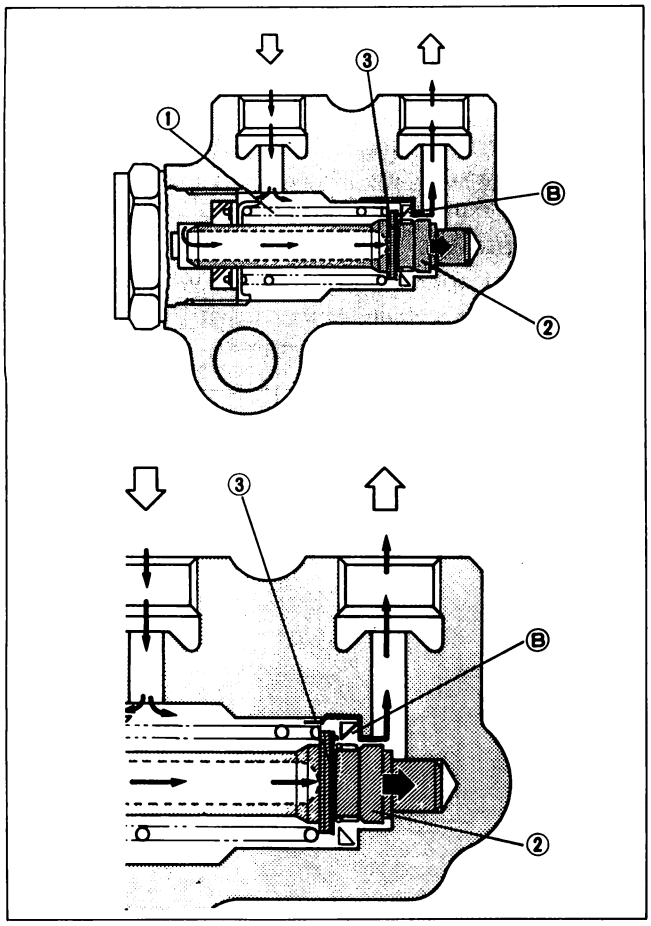




Construction and operation

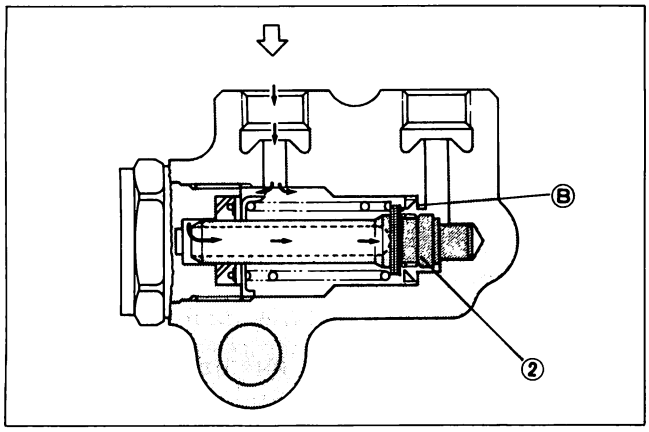
1. When the brake pedal is depressed

The brake fluid pressure on the output side of master cylinder is transmitted to the through passage Ⓑ after entering the P.C.V. from side Ⓐ. As passage Ⓑ dose not close if the brake fluid pressure remains within the range of the road set for the valve spring, the brake fluid pressure on the output side is the same as that input side.

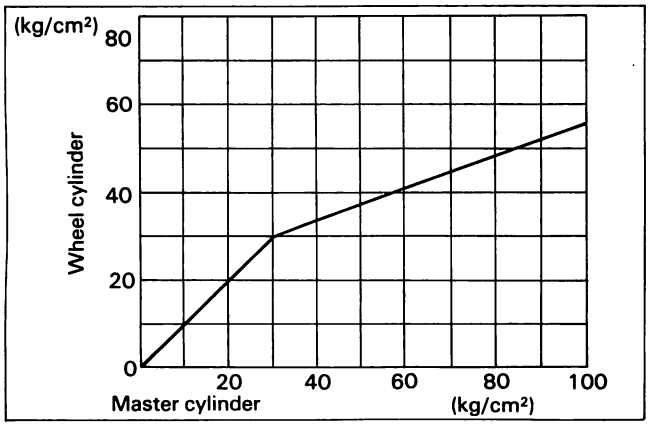


2. If the brake fluid pressure of the master cylinder rises *to above* a certain point

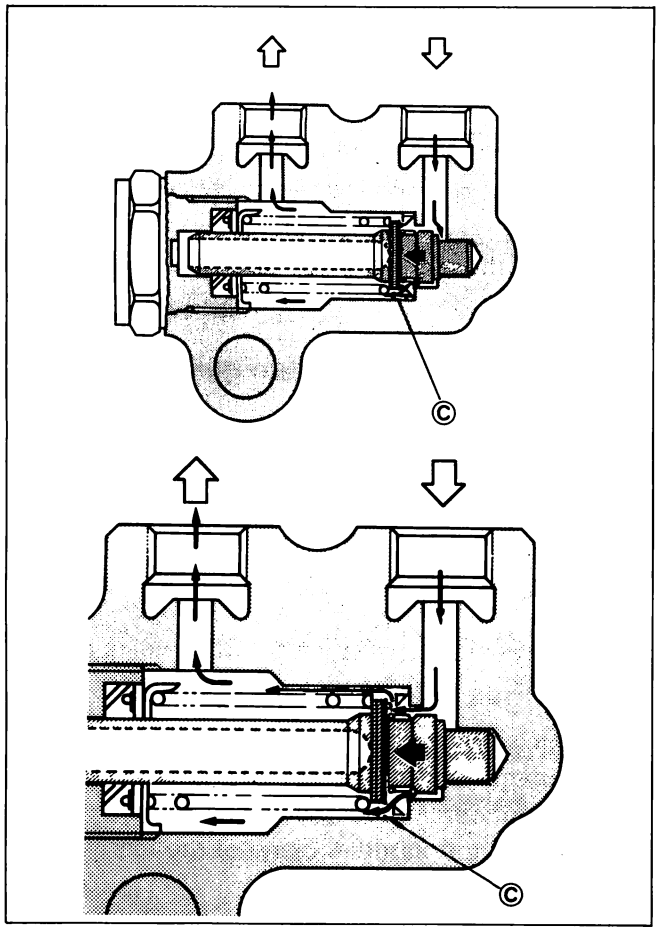
The pressure applied to the wheel cylinder becomes higher than of the valve spring ①, and the piston ② is pushed to the left and the passage B is closed by the valve seat ③.



If the brake fluid pressure of the master cylinder futher rises, it becomes higher than the force (the brake fluid pressure on the wheel cylinder side) that presses the piston ② to that left. Therefore, it pushes back the piston ②, and passage Ⓑ is opened. Then, the brake fluid pressure becomes higher than that on the wheel cylinder and pushs the piston ② to the left and the passage Ⓑ is closed.



The brake fluid pressure of the rear wheel cylinder rises in proportion to the rise of the master cylinder brake fluid pressure though the repetition of the operation. The ratio of the rise of the brake fluid pressure on the master cylinder side and on wheel cylinder side is determined by the shapes of the valve spring and piston.



3. When the brake pedal is released

The master cylinder brake fluid pressure falls, and the rear wheel cylinder brake fluid pressure falls passing through the passage Ⓒ.

Blend vlave

A blend valve is a variation of proportioning valve which is well-known as a control device of the hydraulic pressure supplied to the rear wheel brakes.
The blend valve is, however, a more improved vlave in that it perforoms, in addition to the primary function of the conventional proportioning valve, a function is assuring a sufficient braking performance for the rear wheels when the vehicle is heavily loaded.
The valve is installed as standard equipment for the rear wheels of the recent ISUZU TFR and UBS Service vehicles.

The function of a blend valve

The valve exhibits, its full performance on small-sized vehicles whose wheelbase is short and where there is a relatively great difference between its curb weight and the vehicle weight under loaded condition, that is, vehicles with a payload of around 1,000 kg, like those of the TFR/UBS Series classes. For large-sized trucks, even a proportioning valve is not necessary in many cases. Generally speaking, the blend valve is mainly installed only on small-sized trucks.
The blend valve has the following two functions: (1) function as a conventional proportioning valve and (2) a function characteristics of the blend valve.

(1) Prevents the rear wheels from locking prematurely at curb weight or under light load.
The brake of a truck is designed to show its optimum performance under full load, so the vehicl is likely to spin when the brake is suddenly operated at curb weight or under light load because the rear wheels lock before the front ones. The proportioning valve prevents this premature locking of the rear wheels.

(2) Improves the braking performance of the rear wheel brakes at full load.
As a result of the function (1), there appears a reverse effect in that the rear wheel brakes may supply insufficient force. The blend valve functions to prevent this phenomenon. With the brake pedal depressed firmly, the valve stops functioning as a proportioning valve when the pressure of the rear master cylinder has exceeded a predetermined value and starts to raise the rear wheel cylinder pressure at the same rate, as an increase in the rear master cylinder pressure by the operation of the bypass valve, thereby increasing the rear wheel braking force.

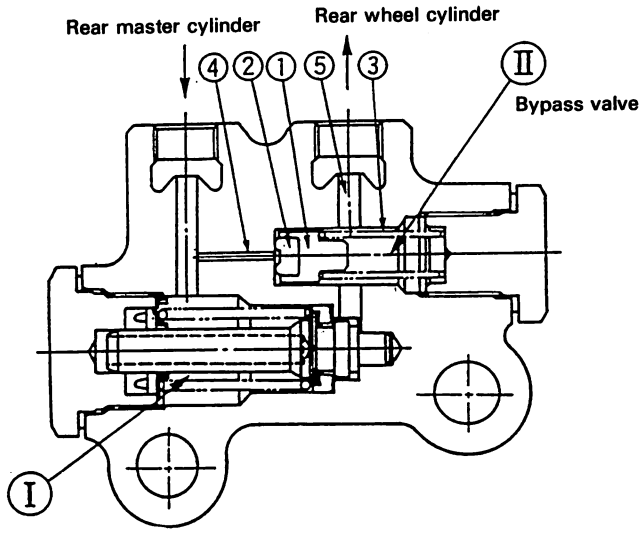
Structure and function of the blend valve

The blend valve is a valve of simple structure which combines the function of the conventional proportioning valve with a bypass function. It is amall in size and light in weight. The number of necessary parts is small and the installation is easy. Its performance is high while its cast is relatively low. The details of the structure and function of the blend valve are shown below:

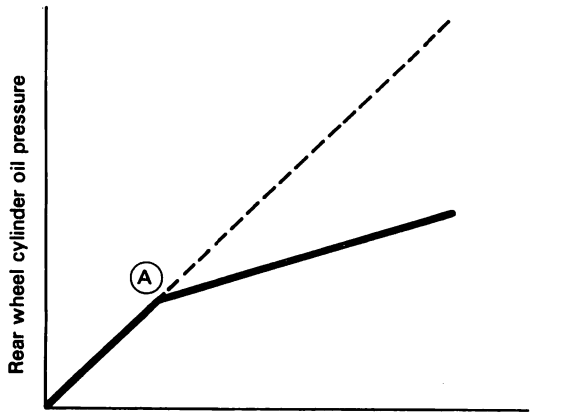
[Structural view]

Referring to the assembly view, Ⓘ shows the proportioning valve while the sign Ⓘ denotes the bypass valve. The bypass valve is provided with a seal ② at the top of the piston ① to seal passages between ④ and ⑤. Spring ③, pushs piston ①, and also pushes seal ② onto the end face of the cylinder in order to completely seal the passages between ④ and ⑤.

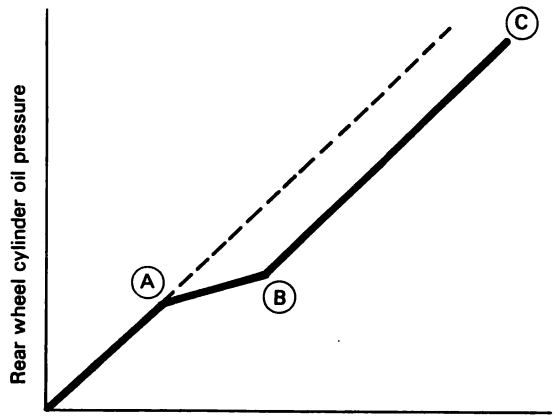
Assembly View



[Operation]



Performance characteristics of conventional proportioning valve



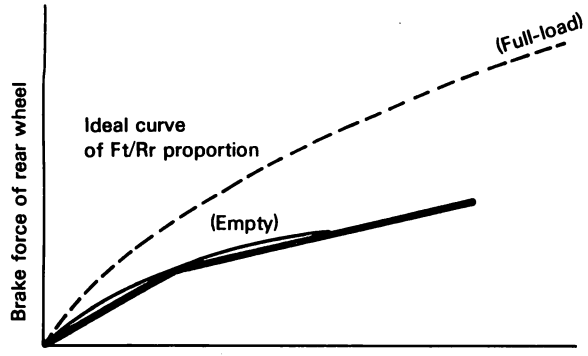
Performance characteristics of blend valve

After the above up to point Ⓒ, the master cylinder and the wheel cylinder increase in the same rates because of the same areas are acting on seal ②. However, the wheel cylinder receives the force from spring ③, thus the liquid pressure of the wheel cylinder becomes blanced with the liquid pressure of the master cylinder with an offset equal to the differential pressure by this spring force.

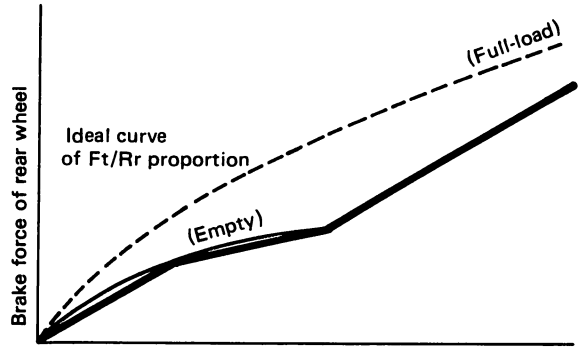
The operation of the blend valve is the same as the conventional proportional valve up to the second knee point Ⓑ of the master cylinder hydraulic pressure via the first knee point Ⓐ.
Where the master cylinder hydraulic pressure reaches the second knee point B , the piston ① is pressed to the right, as hydraulic pressure acting onto seal ② via passages ④ from the master cylinder side overcomes the action force of liquid pressure to the force of spring ③, acting onto seal ② in the wheel cylinder side, thereby communicating passages ④ and ⑤ while activating the proportioning valve.

Braking force distribution to the front and rear wheels

Figure 3 shows a relationship between the hydraulic pressures of the rear master cylinder and rear wheel cylinder with the blend valve installed. Figures 4 and 5 show how the braking force is distributed to the front and rear wheel brakes of a vehicle when the blend valve is used and not used. The upper curve of each figure indicates an idela braking force distribution to the front and rear wheel brakes when the vehicle is under full-load condition.
This "ideal distribution" is, simply, a distribution that will make the front and rear wheels lock simultaneously, depending upon various conditions (axle load, height of the center of gravity, wheelbase, etc.) of each vehicle, thereby stopping the vehicle standby and safely.



Brake-power distribution to
front/rear wheels, in case conventional P-valve used.



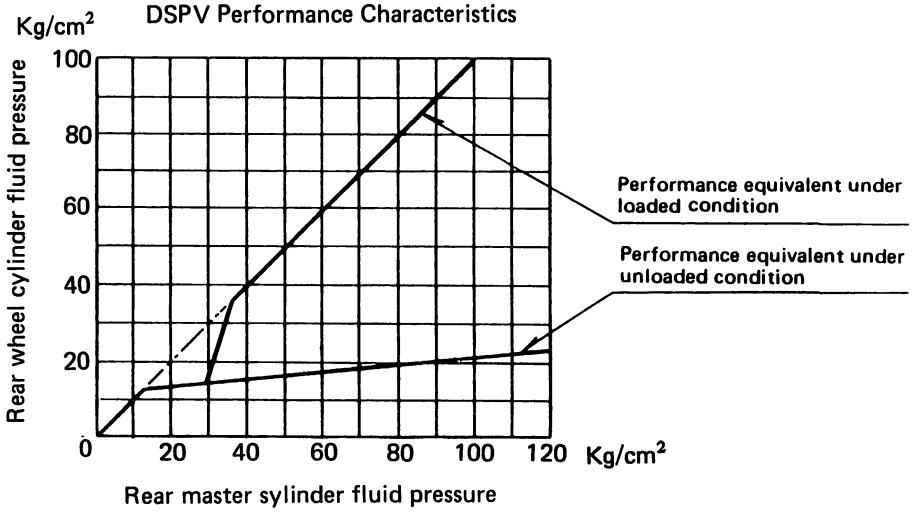
Brake-power distribution to
front/rear wheels, in case blend valve used.

As Figure 4 indicates, when the conventional proportioning valve is used, the actual braking force distribution (indicated by a solid-thick line) gradually goes away from the ideal one (indicated by an dotted line) when the vehicle is fully loaded. Accordingly, the blend valve has been adopted to generate a second knee point to increase the braking force distributed to the rear wheels when a large braking force is necessary under full load. As you can see from Figures, the blend valve brings the actual braking force distribution near to the ideal distribution by increasing the rear wheel braking force like as full load. That is, stability in braking performance is increased.

Decleleration sensing proportioning valve (D.S.P.V.)

Outline of D.S.P.V.

Load distribution on the front wheels and rear wheels of a vehicle varies greatly depending on whether it is loaded or not.
Particularly, the load on the rear wheel varies much between a loade state and an unloaded state.
Braking power is generally distributed between the front and rear wheels in such a way that the brake works most efficiently under the severest loaded condition. If a sudden brake is applied when the truck is no load or lightly load, the rear wheels which have less axle weight stop rotation before the vehicle stops. This locking of the rear wheels car cause directional instability. The D.S.P.V. senses vehicle deceleration with a deceleration sensing ball, and controls the hydrulic pressure to the rear wheel brake to ensure the most efficient operation of it. That is, it assures reliable braking performance without locking the rear wheels regardless of whether the vehicle is loaded or otherwise.
The D.S.P.V. is so set as to control rear wheel locking of a small-sized vehicle when it is without load or with little load.
Thus, its mounting angle varies from one type of vehicle to another. It is necessary to mount the D.S.P.V. at the specified mounting angle because performance depends largely on it.



Construction and function

(1) One bore type

DSPV Components

Proportioning valve (P valve) and control valve

These valves control the fluid pressure on the rear wheel cylinder side. Pressure is raised proportionally to the master cylinder fluid pressure, when the master cylinder pressure exceeds a preset value.

Cutoff vlave (Ball par)

The cutoff valve detects the vehicle decelerating and actuates the P valve for quick braking in loaded or unloaded conditions. It cuts off fluid to the control valve by ball movement. When loaded, pressure to the control valve is reduced to cut off the P valve operation. Sufficient fluid pressure is provided to the wheel cylinder.

Check vlave

This valve closes passage 1 from the master cylinder to the control valve when the fluid pressure drops. It stabilizes the P valve operation for slow or intermediate braking when unloaded.

DSPV Operation

1 When the brake pedal is actuated, fluid pressure from the master cylinder is transmitted to the rear wheel cylinder through passages N' and N.

2 Pressure at the rear wheel cylinder side, when reaching a certain level, exceeds the P valve spring force. This pressure forces the P valve piston to the right, closing passage N. This stops the pressure increase on the wheel cylinder side.

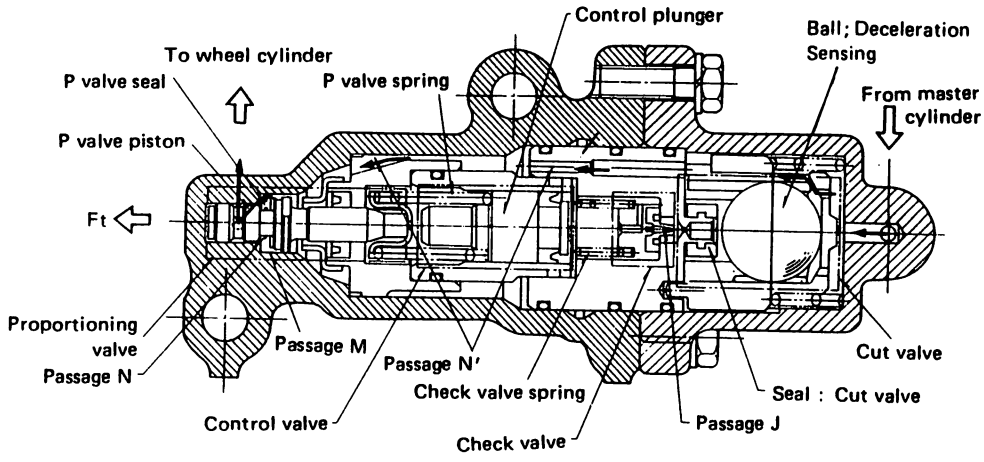
3 If the master cylinder side pressure increases further, the force required to displace the P valve piston to the left exceeds that to displace it to the right wheel cylinder pressure. This opens passage N to permit wheel cylinder pressure increase.

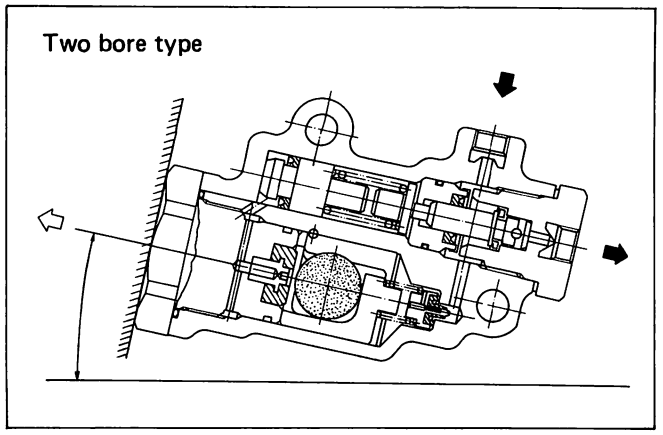
As the pressure on the wheel cylinder side rises, the P valve piston is agian displaced to the right closing passage Ⓝ. The pressure increase on the wheel cylinder side stops.

Through repeating this process, the wheel cylinder pressure rises proportionally to the master cylinder pressure. This reduction ratio is determined by shape and spring force the P valve.

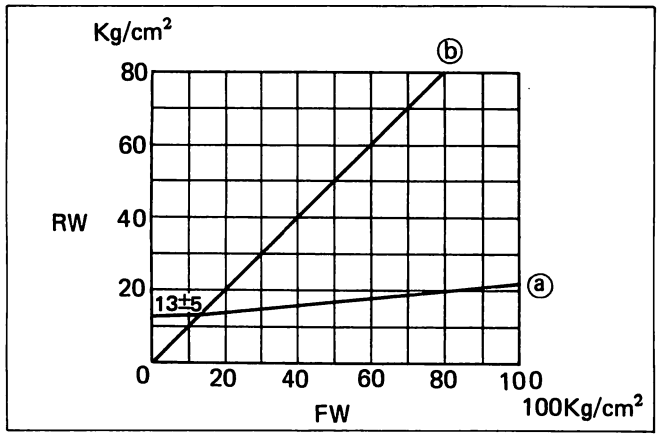
4 If master cylinder pressure increases further, a check valve opens to supply pressure to the right side of a control plunger through passage ⓙ. Then, the control plunger moves to the left displacing the P valve piston and opening passage Ⓝ. Passage Ⓝ remains open to equalize master cylinder and rear wheel cylinder pressure.

5 Paragraph ④ explains operation in loaded conditions. When unloaded, the vehicle decelerates significantly by braking before the master cylinder pressure rises to open the check vlalve. (High deceleration rate as a result of light vehicle weight.) The ball rolls forward to close the valve at the seal. Thus, no pressure is supplied to the control plunger. This allows constant P valve operation to prevent rear wheel locking.





(2) Two bore type



D.S.P.V. Performance characteristics

Fw: Master cylinder fluid pressure

Rw: Rear wheel cylinder fluid pressure

a: With proportioning valve (without load)

b: Without proportioning valve (with half to full load)

As shown, the rear wheel cylinder fluid pressure is kept low by the proportioning valve, control valve, cut valve, and check valve to prevent rear wheel locking of an unloaded vehicle.

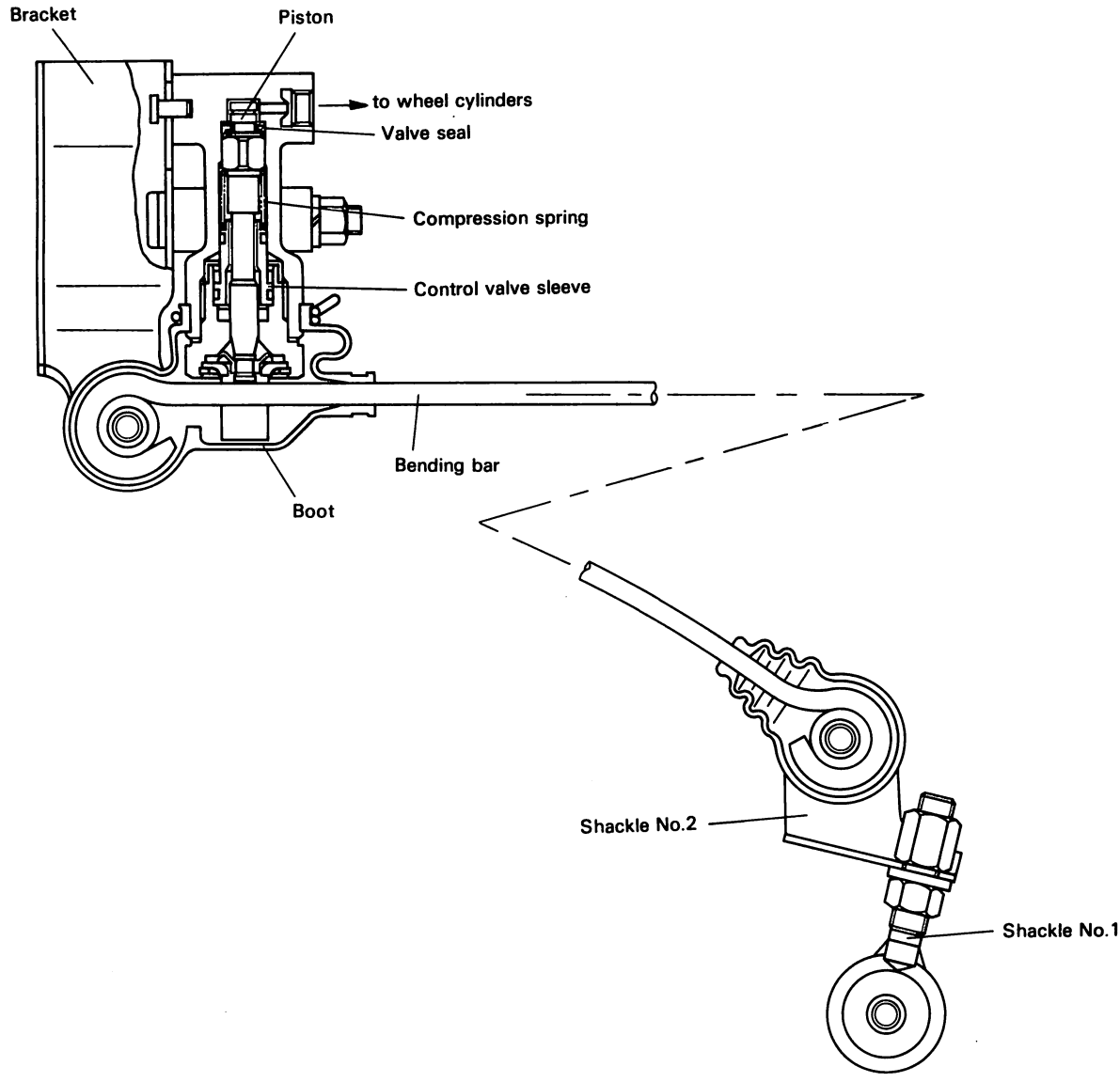
LSPV (Load sensing proportioning valve)

(1) General information

The function of the LSPV is to control the hydraulic pressure applied to the rear wheel cylinder in response to variations in load weight imposed on the rear axle by sensing the rear spring displacement for obtaining propoer braking force.

(2) Construction

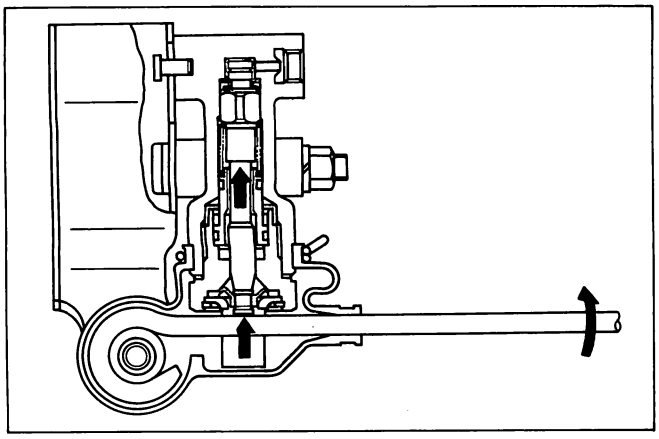
LSPV consists of a load sensing spring (bending bar) and a load sensing valve. The load sensing valve is attached to frame via bracket and one end of load sensing spring is attached to the load sensing valve and the other end to rear axle housing via shackle.



(3) Operation

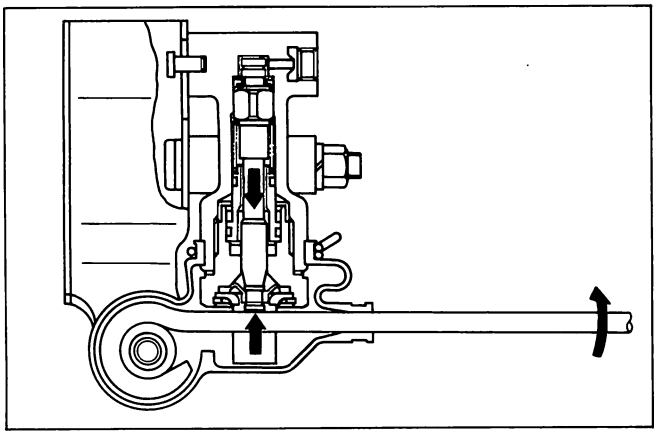
In response to variation in load weight, the sensing spring is bent to push up the lower part of the load sensing valve, whereby the cut point of hydraulic pressure of rear wheel cylinder is secured in response to the load weight.

In the event of front brake system failure, the braking force is obtained without cutting off the hydraulic pressure from the rear master cylindre to the rear wheel cylinder.



1 When hydraulic pressure is below cutting off point

The hydraulic pressure from rear master cylinder action rear wheel cylinder through gap between valve seal and piston. During this time, piston is forced upward by the reactive force of a compression spring and load sensing spring overcoming the downward force of piston.

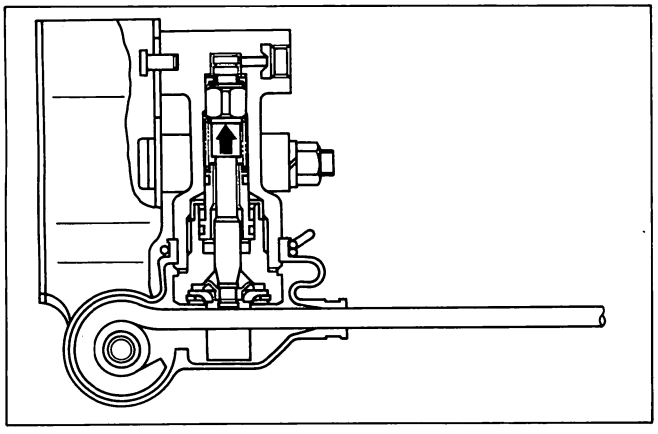


2 When hydraulic pressure is at cutting off point.

When the rear wheel cylinder pressure rises, the piston is forced downward into contact with valve seal overcoming the reactive force of the compression spring and load sensing spring to cut off fluid passage from the master cylinder to the wheel cylinders.

3 When hydraulic pressure is above cutting off point.

As the hydraulic pressure of master cylinder rises higher, the piston goes up again and the instant the piston moves out of engagement with the valve seal, the fluid pressure acts on the rear wheel cylinders and the piston moves downward again to cut off the fluid passage.
This piston operation as mentioned above is repeated to reduce the hydraulic pressure applied to rear wheel cylinders.



4 If front brake system is failed.

Failed front brake system results in a reduction in the hydraulic pressure of front master cylinder.
Therefore, balance of hydraulic pressure exerting on control valve sleeve between front and rear master cylinder is lost, resulting in the control valve sleeve moving upward.
Thus, this sleeve comes in contact with piston that is moved upward.
Therefore, the hydraulic pressure from the rear master cylinder is exected directly on the rear wheel cylinders without being reduced, assuring the rear brake force.