414 DISTRIBUTOR VALVE

Distributor valve is the most important functional component of the air brake system and is also sometimes referred to as the heart of the air brake system. The distributor valve senses drop and rise in brake pipe pressure for brake application and release respectively. It is connected to the brake pipe through branch pipe. Various other components connected to the distributor valve are auxiliary reservoir, brake cylinders and control reservoir.

414a Function of Distributor Valve

For application and release of brakes the brake pipe pressure has to be reduced and increased respectively with the help of driver's brake valve. During these operations the distributor valve mainly performs the following functions.

(i) Charges the air brake system to regime pressure during normal running condition.
(ii) Helps in graduated brake application, when pressure in brake pipe is reduced in steps.
(iii) Helps in graduated brake release, when pressure in brake pipe is increased in steps.
(iv) Quickly propagates reduction of pressure in brake pipe throughout the length of the train by arranging additional air pressure reduction locally inside the distributor valve.
(v) Limits maximum brake cylinder pressure for full service application/ emergency application.
(vi) Controls the time for brake application and brake release depending on service conditions
(vii) Facilitates complete discharge of air from the air brake system manually with the help of operating lever.
(viii) Protects overcharging of control reservoir when the brake pipe pressure is quickly increased for releasing the brakes.

Three designs of distributor valves are in use on coaches. These are:

i) C3W Type distributor valve
ii) KE type distributor valve.
iii) P4aG type distributor valve.

415 C3W DISTRIBUTOR VALVE (refer figure 4.14)

The C3W Distributor Valve consists of:

i. Main body
ii. Quick Service valve
iii. Main valve
iv. Limiting device
v. Double release valve
vi. Auxiliary reservoir check valve
vii. Cut off valve
viii. Application choke
ix. Release choke.

415a Operation of C3w Distributor Valve (Refer Fig 4.14)

For effective functioning of the air brake system, the distributor valve has to operate effectively during

i) Charging stage
ii) Application stage and
iii) Release stage

i) Charging Stage

During charging stage the compressed air flows from the brake pipe and enters into the brake pipe chamber of the main valve, cut off valve and quick service valve. Due to this pressure the various valves get, activated and perform as under.

Main Valve : Due to brake pipe pressure acting on top face of the large diaphragm, differential pressure acts on the main valve. As a result the hollow stem moves downwards there by connecting brake cylinder to atmosphere. (shown by arrow in figure 4.14)

In addition to this because of BP pressure at top of large diaphragm it presses ring and trigger. This action unlocks the CR release valve by raising upward the locking rod.

Cut Off Valve: As brake pipe pressure enters into the cut off valve it flows through the solex jet and valve, (which is held open due to action of BP pressure on bottom side of the lower diaphragm) to the control reservoir. As the CR & BP pressure equalises, diaphragm assembly come down and valve reach to lap position. The control reservoir pressure now also reaches to the upper portion of top diaphragm of quick service valve and the bottom portion of large diaphragm of main valve.

Simultaneously, the auxiliary reservoir is charged with BP pressure reaching from cut off valve chamber - via auxiliary reservoir check valve.

ii) Application Stage

EMERGENCY APPLICATION

During emergency application the brake pipe pressure is reduced rapidly to **0 kg/cm^2** by the driver's brake valve. Because of this drop the position of the various valves will be as described below.

Main valve: With drop in BP pressure to **0 kg/cm^2** differential pressure acts across the large diaphragm. As a result the hollow stem is moved in upward direction and pushes the check valve there by opening the passage for entry of auxiliary reservoir pressure at top portion of main valve. This pressure then gets a way to brake cylinder through limiting device. The brake cylinder thus gets charged with the compressed air. This pressure is known as BC-pressure.

Limiting Device: The auxiliary reservoir pressure which entered into the top position of main valve now enters the limiting device through the valve which is held open. From limiting device air pressure now enter the brake cylinder. When the BC pressure rises to **3.8 kg/cm^2** the upwards force on the diaphragm lifts the guide and the valve at the bottom of the limiting device gets closed. Thus further entry of air into the brake cylinder stops.

When the brake cylinder pressure reaches **3.8 kg/cm^2** this pressure i.e. BC pressure act on

- Top face of small diaphragm of main valve
- Bottom face of upper diaphragm of cut off valve
- Top (small chamber) of quick service valve

Now because of this BC pressure acting at main valve small diaphragm, the hollow stem is pulled down. As a result the check valve at top comes down to close stage and assume lap position with the hollow stem closing further entry of AR pressure.

Cut off valve: In cut off valve the bottom face of the upper diaphragm is

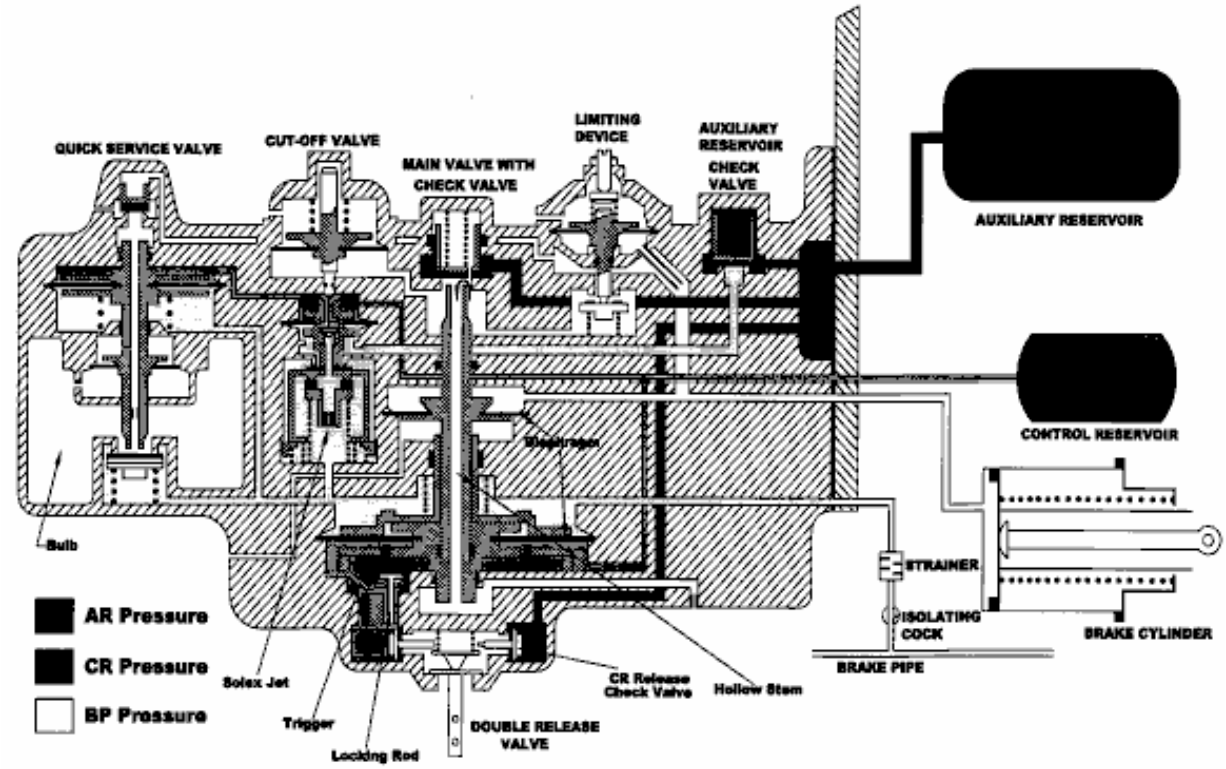

Fig. 4.14 C3W DISTRIBUTOR VALVE

subjected to BC pressure because of which the guide is lifted. Also the upper portion of lower diaphragm is subjected to CR pressure, which pushes the total assembly downwards. This action closes the valve of cut off valve, there by isolating it from control reservoir pressure.

Quick Service Valve : In quick service valve BC pressure acts at the top of valve and control reservoir pressure act at top face of upper diaphragm. As a result the stem is pushed down. The valve at the bottom gets opened. Now as the BP pressure inside the DV is at **"O" kg/cm^2** the residue BP pressure from the bulb of quick service valve will flow back and vent to atmosphere with the BP line.

GRADUATED APPLICATION

During graduated brake application the brake pipe pressure is dropped in steps by driver's brake valve. The movement of various valve assemblies is almost in the same direction as during emergency application, but their movement is comparatively less. In the main valve however after each application the hollow stem assumes the lap position with the check valve.

In addition to this during graduated application the bottom valve of limiting device is held open to allow compressed air to enter into brake cylinder.

When BC pressure reaches **3.8 kg/cm^2** the bottom valve in the limiting device gets closed. Similarly at the time of full service application as the BC pressure reaches **3.8 $\pm$ 0.1 kg/cm^2** within specified time, the position of various valve assemblies will be the same as described above.

iii) Release Stage

When the brake pipe pressure is increased in steps for graduated release of brakes the position of the different valves is as described below;

Main valve : At the top face of large diaphragm as the BP pressure increases, the hollow stem is moved downward leaving its lap position with check valve. The BC pressure thus finds a passage from top of hollow stem to exhaust to the atmosphere. This action reduces pressure on top of the upper diaphragm and the hollow stem again lifts up to lap position. It close the hollow stem top portion. The same cycle is repeated when BP is increased during next stages. In this way graduated release effect is obtained.

Cut off valve: As the BP pressure increases the position of cut off valve remains similar as in graduated application i.e. the cut off valve will remain closed, isolating CR pressure from brake pipe pressure.

Quick service valve : When the BP pressure is increased then as explained above for the main valve the BC pressure gets exhausted to atmosphere. This action gradually reduces the BC pressure. When BC pressure reduces to **0.8 kg/cm^2** during brake release the force at the top of the quick service valve, becomes comparatively less than BP pressure present in Quick Service Valve. As a result the valve at top gets lifted thereby giving passage to blocked BP pressure to atmosphere. With the exhaust of BP pressure the Quick service valve of the distributor valve again gets ready for next brake application.

Manual release: Double release valve provides for accelerated manual brake release, which is particularly useful during shunting operation. A short pull on the lever of double release valve is all that is needed. This action opens the control reservoir release check valve, which is then held open by the locking rod. Venting of control reservoir through the open control reservoir release check valve brings the main valve to release position and exhausts the brake cylinder pressure through the hollow stem.

415b Periodicity of Overhauling

The overhauling of the distributor valve is carried out once in five years or on completion of 8 lakh km whichever is earlier or if there is some specific trouble.

415c Overhauling

C3W Distributor Valve consists of various sub-assemblies possessing highly finished, accurate and sophisticated small parts and therefore need a well arranged work-shop equipped with standard tools

as well as specially designed tools and fixtures. It is also important to state that the work place (DV-overhauling section of the workshop) should be a clean, well organized, dust & dirt free and a properly developed space where the following activities should be adjacently and separately organized:-

a) dismantling and cleaning
b) assembling and testing
c) storage of assembled distributor valve &
d) storage of spare parts including POH kits stocking store etc.

The tools and fixtures required for the disassembly and assembly of C3W distributor valve are given in table below.

415d Tools and Fixture for Overhauling of C3W Distributor Valve

Table 4.5

Sr. No.	Description
1	Open end spanners of 24-27 mm, 20-22 mm, 17-19 mm and 11-13 mm
2	Socket wrenches of size 13mm,17mm,19mm, 22mm, 27mm & 32mm with driving handles – a. Simple L Shaped b. Reversible ratchet and c. Torque calibrated for (1.5 to 6 Kg.m) range
3	Ring spanner (32-36 mm)
4	Allen key (6 mm)
5	Circlip pliers internal & external both (Small & Medium)
6	Plier general design and long nose separately
7	Screw drivers (5 mm and 8 mm blade sizes)
8	Nylon hammer
9	Special tools 1. SCT-6014-pin end tool 2. SCT-6016-pin end tool 3. SCT-6015-'O' ring set tool 4. SCT-6017-hollow stem-lead-tool 5. SCT-6026-spetula (bent tool) 6. SCT-6092-socket spanner 7. RPBF-0003-) fixture for holding guide (76) 8. Air jet gun with flexible hose
10	Bench mounted DV - holding fixture

415e Overhauling Procedure

Before opening the distributor valve, it needs to be dusted and cleaned externally. The disassembling and assembling of the distributor valve in the workshop is facilitated by using a bench mounted DV-holding fixture, with facility to rotate through 360^0 in the vertical plane and locking it after every 90^0 rotation.

The distributor valve is mounted on the fixture and can be locked in any desired position. The sub assemblies of different valve are dismantled in the sequence. It is imperative that components of each sub assembly have to be carefully handled and arranged in an identifiable group sequence. For part numbers and name of components of various sub-assemblies/valves, refer to the concerned manufacturer's maintenance manual.

For POH kit, refer annexure no. 4.1.

415f Testing of Distributor Valve (Refer Fig 4.15)

For the proper functioning of the Air Brake System, it is necessary to test the Distributor Valve.

415g Test Procedure

Tests are conducted in a particular sequence for reducing the time required in opening and closing of various valves. In the test bench described above, following test sequence is optimum as far as the time required in testing distributor valves are concerned. In any other type of test bench arrangement, some other test sequence may be optimum.

Testing of distributor valve is conducted in two steps i.e. first for single pipe operation and then for twin pipe operation. A distributor valve which is able to pass tests for single pipe operation requires only one or two more tests to show its capability to operate in twin pipe system.

i) Single Pipe operation.

V1 is kept closed during single pipe operation. (Since V1 is the valve which controls supply of air to the feed pipe at 6 Kg/cm^2).

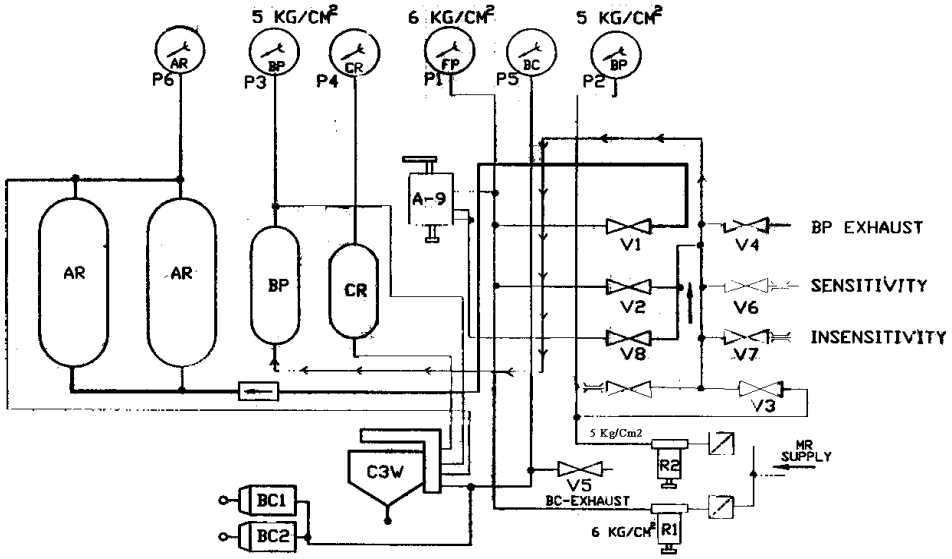

Figure 4.15 -TEST RACK FOR C3W DISTRIBUTOR VALVE

Charging time of auxiliary reservoir and control reservoir.

a) Close all the isolating cocks.
b) Set air pressure regulator R1 and R2 at **6 and 5 Kg/cm^2** respectively.
c) Check pressure in the feed pipe and the brake pipe by P1 and P2. It should be **6 and 5 Kg/cm^2** respectively. If required adjust the pressure regulator R1 and R2 to achieve these pressures before doing testing of DVs.
d) Open isolating cock V3 and with the help of a stop watch, note time taken by gauge P4 (CR) and P6 (AR) to rise from **0 to 4.8 Kg/cm^2**
e) For control reservoir, the charging time should be **260±20 seconds** and for auxiliary reservoir it should be **270±30 seconds**.

Pressure tightness test

a) Apply soap water all over the C3W valve body. No leakage is permissible.
b) Close isolating cock V3 after pressure gauges. P3 (Brake pipe), P4 (Control reservoir) and P6 (Auxiliary reservoir) indicates **5 Kg/cm^2**. Wait till reading in gauges settle.
c) Switch on a stopwatch and monitor pressure in these gauges. There should be no drop in pressure in one minute duration.

Full service application and release test.

a) Automatic brake valve should be set at **5 Kg/cm^2** (as done during setting of the test bench). Bring handle in release position.
b) Open isolating cock (V8) and note gauges P4 (CR) and P6 (AR) shows exactly **5 Kg/ cm^2**.
c) Move A9 handle to service application position , so that P3 (Brake pipe pressure) falls from **5 to 3.4 Kg/cm^2**.
d) Switch on the stop watch as soon as the handle of A9 is moved to service application position in the above step and note the time taken by brake cylinder pressure (P5) to rise from **0 to 3.6 Kg/cm^2**. This time should be **3 to 5 seconds**.
e) Wait for brake cylinder pressure (P5) to settle and note the maximum pressure to which it reaches. The maximum pressure should be **3.8±0.1 Kg/cm^2**.
f) Move A9 handle to release position and switch on the stop watch immediately to

note the time taken by brake cylinder pressure (P5) to fall from **3.8 to 0.4 Kg/cm^2**. This time should be within **15 to 20 seconds**.

Overcharge protection test

a) When A9 handle is in release position, brake pipe, auxiliary reservoir and control reservoir pressures i.e. pressures in gauges P3, P4 and P6 should be at **5 Kg/cm^2**.

b) Move A9 handle to emergency position. In this case brake pipe pressure (as per gauge P3) will fall to zero and brake cylinder pressure (as per P5) will reach to its maximum value.

c) Close isolating cock V8 and move A9 handle to release position. In this position brake pipe pressure (P3) will again rise to **5 Kg/cm^2** and brake cylinder. Pressure (P5) will fall to zero, while auxiliary reservoir pressure (P6) and control reservoir pressure (P4) will be around **5 Kg/cm^2.**

d) Open isolating cock V2 and overcharge brake pipe to **6 Kg/cm^2 for 25 seconds** (see it in gauge P3) and then immediately close isolating cock V2 and open cock V8. But during this, control reservoir should not be overcharged by **0.1 Kg/cm^2** over regime pressure of **5 Kg/cm^2** (as seen by gauge P4).

CR over charge reduction test

a) Allow over charging of CR and AR at 5.7 Kg/cm^2 and bring back BP pressure to **5 Kg/cm^2** by closing the isolating cock V2 and V1.

b) Pull the double release lever of DV for 3 seconds and note down the fall in pressure of control reservoir.

c) The control reservoir pressure should return back to brake pipe pressure i.e. **5 Kg/cm^2** as seen by P3.

Emergency application test

a) With brake pipe, control reservoir and auxiliary reservoir (i.e. P3, P4 and P6) charged **to 5 Kg/cm^2**. Move A9 handle to emergency application position.

b) As soon as handle is moved to emergency application position, switch on the stop watch and note down the time taken by the brake cylinder pressure (P5) to rise from **0 to 3.6 Kg/cm^2**. This time should be between **3 to 5 seconds.**

c) Also note the maximum pressure to which brake cylinder is charged. This pressure should be **3.8±0.1 Kg/cm^2**.

Sensitivity test

a) Move A9 handle to release position to recharge the brake pipe pressure (P3) to **5 Kg/cm^2**.
b) Close isolating cock V8.
c) Open isolating cock V6. Switch on the stop watch as soon as isolating cock V6 is opened and note the time taken by brake application. This time should be **6 seconds**.

Quick service test

Close isolating cock V6 and immediately observe the applied brakes, they should remain applied.

Insensitivity test

a) Open isolating cock V3 to recharge BP, CR and AR to **5 Kg/cm2** (as seen by P3, P4 and P6).
b) Close isolating cock V3 and open isolating cock V7.

c) As soon as isolating cock V7 is opened, start stop watch and check that BP pressure (P3) drops by **0.3 Kg/cm^2** in 60 seconds.
d) There should not be any rise in brake cylinder pressure and brake cylinder piston should not start moving i.e. brakes should not apply.

Re-feeding test

a) Close isolating cock V7 and open V3 to recharge brake pipe, control reservoir and auxiliary reservoir to **5 Kg/cm^2** (As seen by P3, P4 and P6 respectively).
b) Bring A-9 valve handle to full service application position. BC pressure will become **3.8±0.1 Kg/cm^2** (as seen by P5).
c) Exhaust the brake cylinder by slightly opening the isolating cock no V5.
d) Observe brake cylinder pressure in the gauge no.P5. It should not become zero and should stabilize at some particular value (since re-feeding to brake cylinder is available via distributor valve).
e) Fall in brake cylinder pressure should not be more than **0.15 Kg/cm^2** from **3.8±0.1 Kg/cm^2** (i.e. it should not fall below **3.65±0.1 Kg/cm^2**).
f) Close exhaust cock no. V5.

Graduated application test

a) See that brake pipe, control reservoir and auxiliary reservoir are at **5 kg /cm^2** (as seen by P3, P4 and P6 respectively).
b) Close isolating cock V3.
c) Decrease P3 (BP) pressure by steps **of 0.2 Kg/cm^2** (min 7 steps) by slowly opening and closing cock V6 i.e. starting from **4.6 Kg/cm^2** and then **to 4.4, 4.2, 4.0, 3.8, 3.6 and 3.4 Kg/cm^2.**
d) Note down the corresponding increase in brake cylinder pressure (P5).
e) Also note the brake pipe pressure (P3) at maximum brake cylinder pressure (P5). This BP pressure (P3) should be **3.4 to 3.7 Kg/cm^2.**

Graduated release test

a) Close isolating cock V6.
b) Increase brake pipe pressure (P3) by steps of **0.2 Kg/cm^2** by opening and closing cock V9. The Brake pipe pressure will rise from **3.6 to 3.8 Kg/cm^2**.
c) Note corresponding decrease in the brake cylinder press ure (P5).
d) Also note the maximum pressure of brake pipe (P3) at which brake cylinder pressure (P5) is exhausted completely. This pressure should be **4.85 Kg/cm^2**.

Quick release test

a) Close isolating cock V9.
b) Open isolating cock V3 to charge brake pipe, auxiliary reservoir and control reservoir pressure (P3, P4 and P6) to **5 Kg/cm^2**. Close isolating cock V3 when pressure in P3, P4 and P6 stabilizes.
c) Open isolating cock V4 for emergency application and see that. Brake cylinder (P5) is charged to **3.8 Kg/cm^2**.
d) Make a short pull on the release valve handle, as soon as this handle is pulled, control reservoir (P4) and brake cylinder (P5) should be completely vented.
e) Close cock V4.

CR check valve reset test

a) Continue to pull the release valve handle of the distributor valve to completely vent out auxiliary reservoir (P6).
b) Recharge by opening cock V9.
c) Control reservoir (gauge P4) should be isolated from the atmosphere when brake pipe (gauge P3) pressure exceeds **0.2 Kg/cm^2.**

ii) Twin pipe operation

- Start test with system completely empty and all the isolating cocks are closed.
- Open isolating cock V1 to charge AR (P6) to **6 Kg/cm^2**.
- Open isolating cock V3 to charge brake pipe (P3) and control reservoir (P4) to **5 Kg/cm^2**.
- Close isolating cock V3 as soon as pressure in gauge P3 and P4 is stabilized.
- Repeat service application & release test and emergency application test as described above.