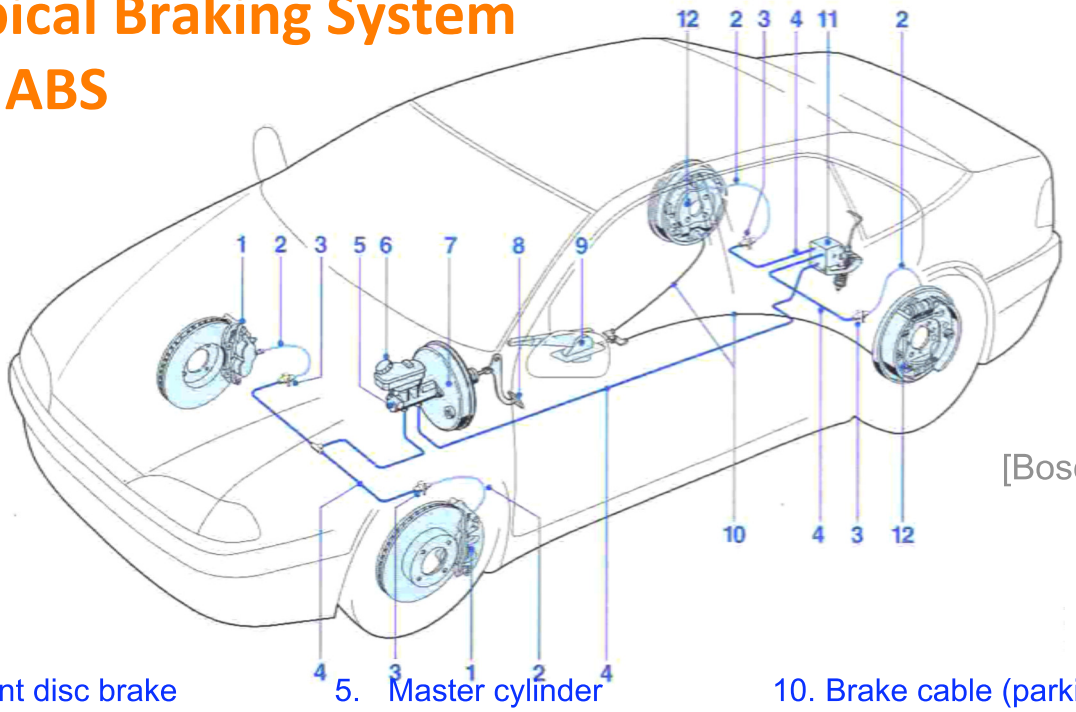
A Typical Braking System -Non ABS



[Bosch]

1. Front disc brake
2. Brake hose
3. Connecting union b/n brake pipe and hose
4. Brake pipe
5. Master cylinder
6. Brake-fluid reservoir
7. Brake servo unit
8. Brake pedal
9. Hand brake lever
10. Brake cable (parking brake)
11. Braking-force reducer
12. Rear brake (drum brake in this case)

Modifying Brake Force Distribution

- To avoid rear wheel lock-up without sacrificing braking efficiency, a rear pressure proportioning valve is used.
  - Possible law: a linear reduction of rear pressure when the system pressure increases beyond a threshold.

$$p_2 = p_1 \qquad if \;\; p_1 < p_i$$

$$p_2 = p_i + \rho_c (p_1 - p_i) \;\; if \;\; p_1 > p_i$$

  - ρ_c : valve characteristic constant
  - p_i : changeover/threshold pressure.

- These design parameters should be chosen to keep the braking efficiency near 100%.

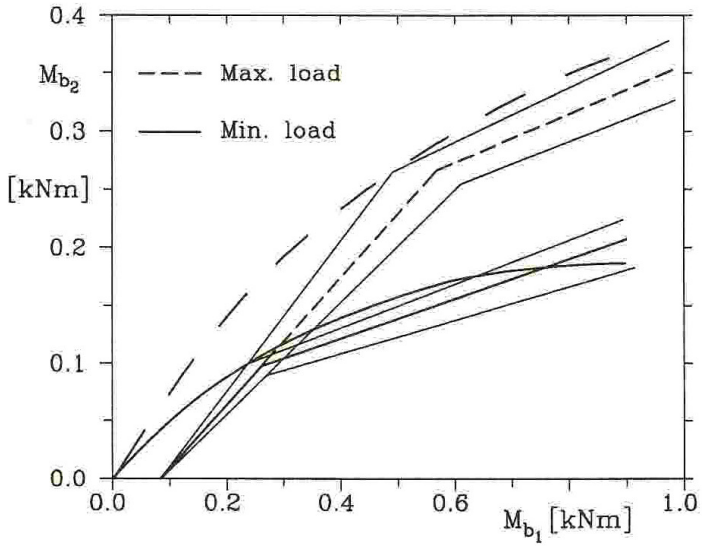
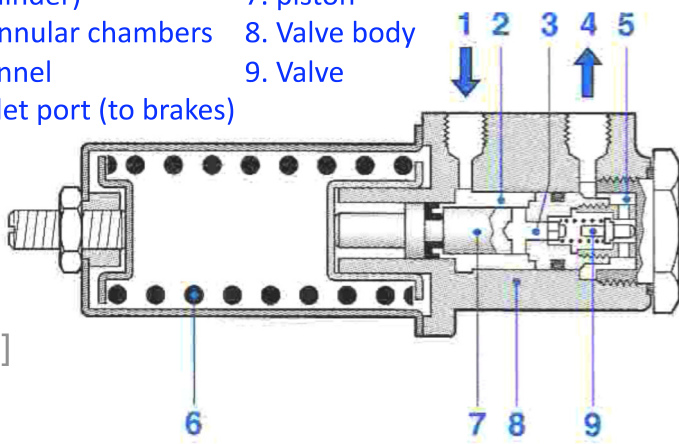


Fig: distribution with brake proportioning valve. Plot considers possible variations in system characteristics, pad friction etc.

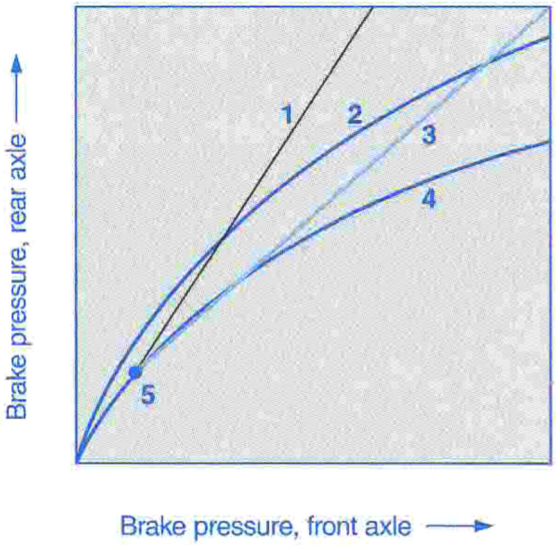
Brake Proportioning: Some Solutions

A. Static/fixed setting pressure regulating valve

1. Inlet port (from master cylinder)
2, 5. Annular chambers
3. Channel
4. Outlet port (to brakes)
6. Compression spring
7. piston
8. Valve body
9. Valve



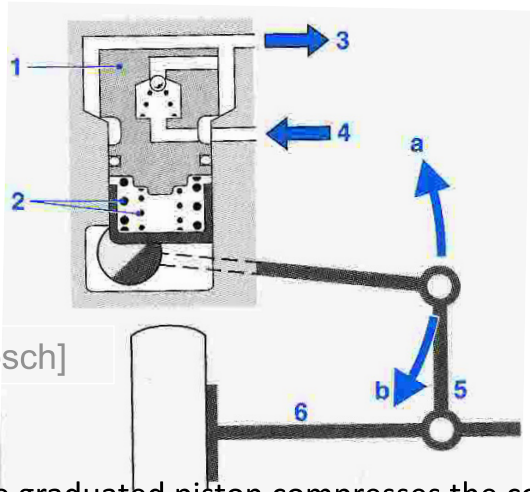
[Bosch]



1. Unregulated pressure
2. Ideal pressure curve(loaded vehicle)
3. Regulated pressure
4. Ideal pressure curve (unloaded vehicle)
5. Changeover point

Near changeover, the valve 9 is pushed to the right to close off port 4. Beyond that the valve 9 moves rapidly back and forth to reduce the output pressure w.r.t. the input pressure in proportion to the effective areas of annular chambers (2,5).

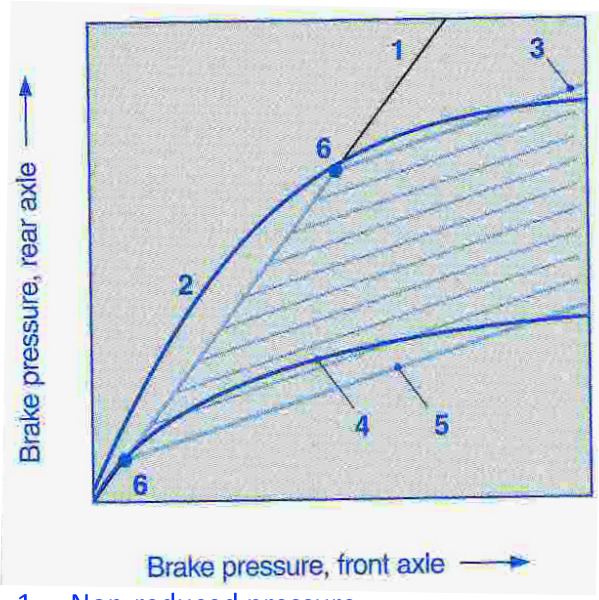
B. **Load dependent pressure regulating valve**



[Bosch]

The graduated piston compresses the control springs in proportion to suspension travel thereby adjusting the changeover point.

1. Graduated piston
2. Control springs
3. Outlet port to brakes
4. Inlet port from master cylinder
5. Linkage
6. Rear Axle
   a. **Loaded vehicle**
   b. **Unloaded vehicle**

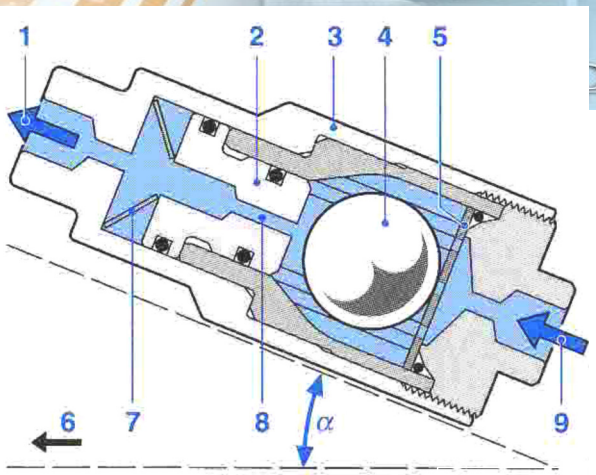


1. Non-reduced pressure
2. Ideal curve(loaded vehicle)
3. Reduced pressure (loaded vehicle)
4. Ideal pressure curve (unloaded vehicle)
5. Reduced pressure(unloaded vehicle)
6. Changeover points

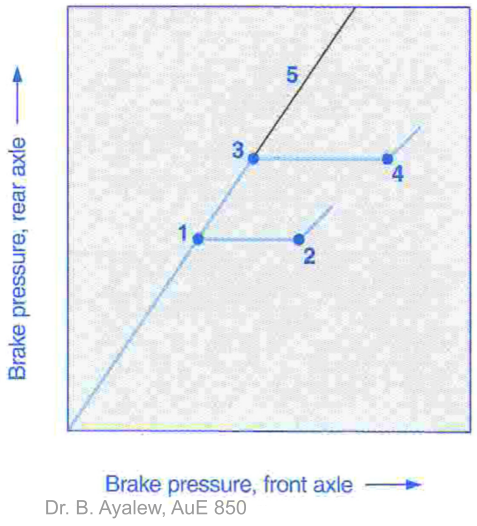
C. **Deceleration-dependent pressure regulating valve**

- Load as well as deceleration rate dependent adjustment of changeover point

1. Outlet port (to brake)
2. Stepped piston
3. Valve body
4. Ball
5. Perforated disk
6. Fornt of vehicle
7. Leaf spring
8. Channel
9. Inlet port (from master cylinder)



α -angle to horizontal [Bosch]



1, 2 changeover points (unloaded vehicle)
3, 4. Changeover points (loaded vehicle)
5. Unregulated pressure

The inertia of the ball pushes it up the incline to close off channel 8 (at the first changeover point 1 or 3). (pressure limiting)
With further increase in inlet pressure 9, piston 2 pushes the spring, channel 8 opens (second changeover point (2 or 4))