Braking systems used in Indian Railways
&
Its Development for Passenger Safety.

A Railway Brake:

- A **railway brake** is a type of brake used on the rolling stock of railway trains to enable deceleration, control acceleration (downhill) or to keep them immobile when parked.

- While the basic principle is similar to that on road vehicle usage, operational features are more complex because of the need to control multiple linked carriages and to be effective on vehicles left without a prime mover.
- Clasp brakes are one type of brakes historically used on trains.

Introduction Mechanical Braking System:

- In the earliest days of railways, trains were slowed or stopped by the application of manually applied brakes on the locomotives and in brake vehicles through the train Brake Porters, and later by steam power brakes on locomotives.
- This was clearly unsatisfactory, given the slow and unreliable response many times.
- Each brake being separately applied by a member of the train crew in response to signals from the driver, which they might miss for any number of reasons, and necessarily in sequence rather than all at once where there were more brakes than crew members, making emergency braking extremely hit-and-miss) and extremely limited braking power that could be exerted (most vehicles in the train being wholly unbraked.

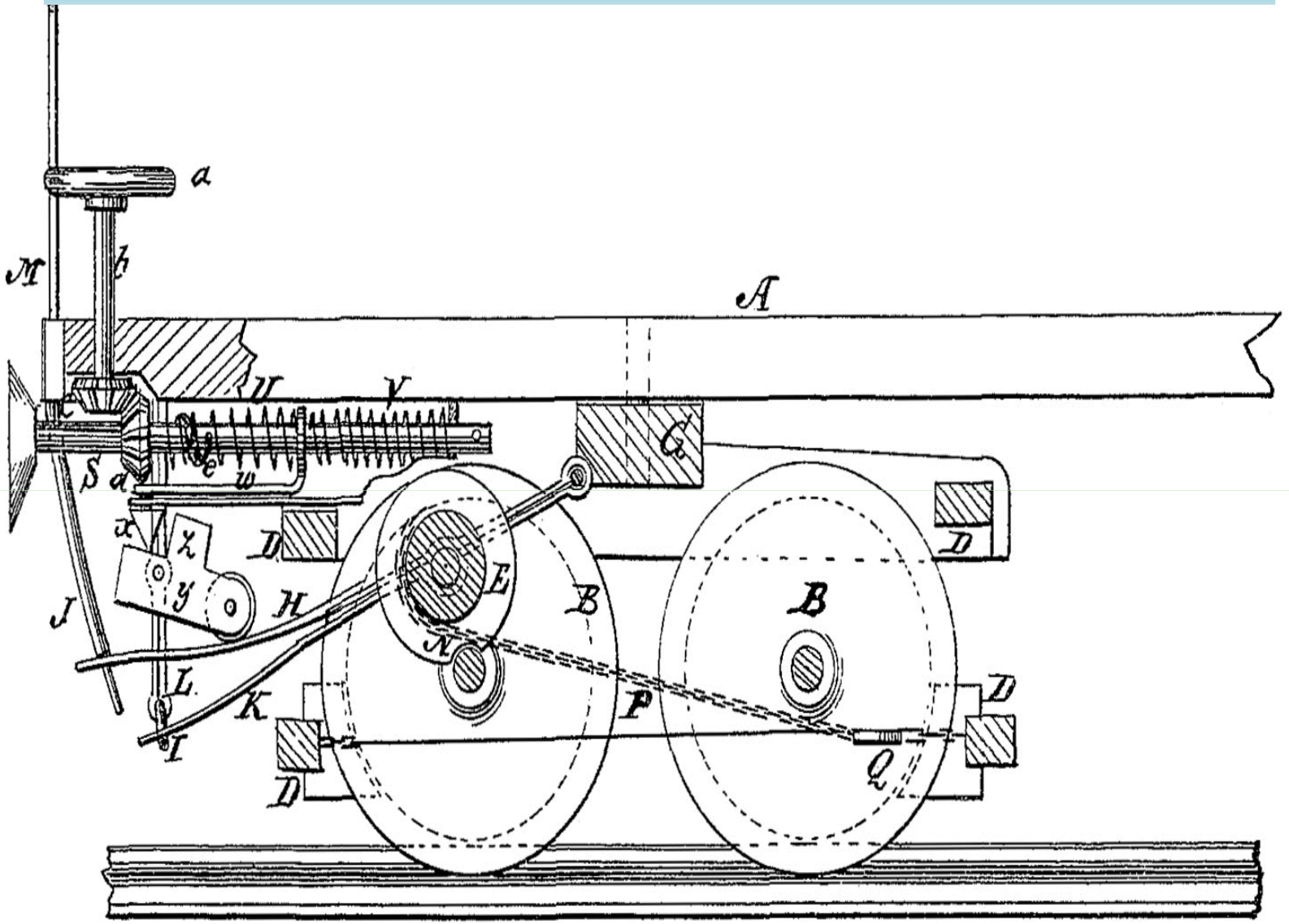
- The power of all but the locomotive's own brakes relying on the strength of a particular crewmember's arm on a screw handle), but the existing technology did not offer an improvement.

- A chain braking system was developed, requiring a chain to be coupled throughout the train, but it was impossible to arrange equal braking effort along the entire train.

Working Principle of Mechanical Brakes:

- In the Early Stage of Railways the braking technology was primitive.
- The first trains had brakes operative on the locomotive tender and on vehicles in the train, where "Brake Porters" in United Kingdom or, "Brakemen" in the United States is travelling for the purpose on those vehicles and operated the brakes.
- Some railways fitted a special deep-noted brake whistle to locomotives to indicate to the porters the necessity to apply the brakes.

Railway Mechanical Braking System



- These Brakes are completely Mechanical and there operation is completely dependent on the skills of the Brake Porters in United Kingdom & “Brakemen” in the United States.
- All the brakes at this stage of development were applied by operation of a screw and linkage to brake blocks applied to wheel treads, and these brakes could be used when vehicles were parked.
- In the earliest times, the porters travelled in crude shelters outside the vehicles, but "assistant guards" who travelled inside passenger vehicles, and who had access to a brake wheel at their posts, supplanted them.
- The braking effort achievable was limited and it was also unreliable, as the application of brakes by guards depended upon their hearing and responding quickly to a whistle for brakes.

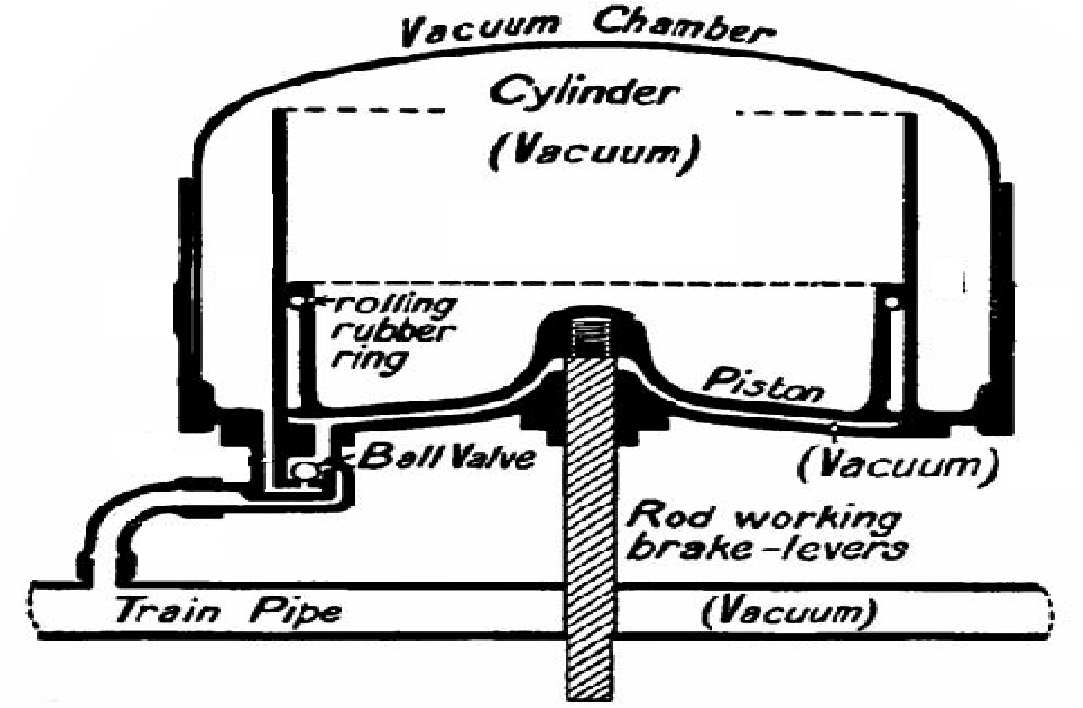
- An early development was the application of a steam brake to locomotives, where boiler pressure could be applied to brake blocks on the locomotive wheels.
- As train speeds increased, it became essential to provide some more powerful braking system capable of instant application and release by the train operator, described as a *continuous* brake because it would be effective continuously along the length of the train.
- Hence Vacuum Brakes are Introduced.

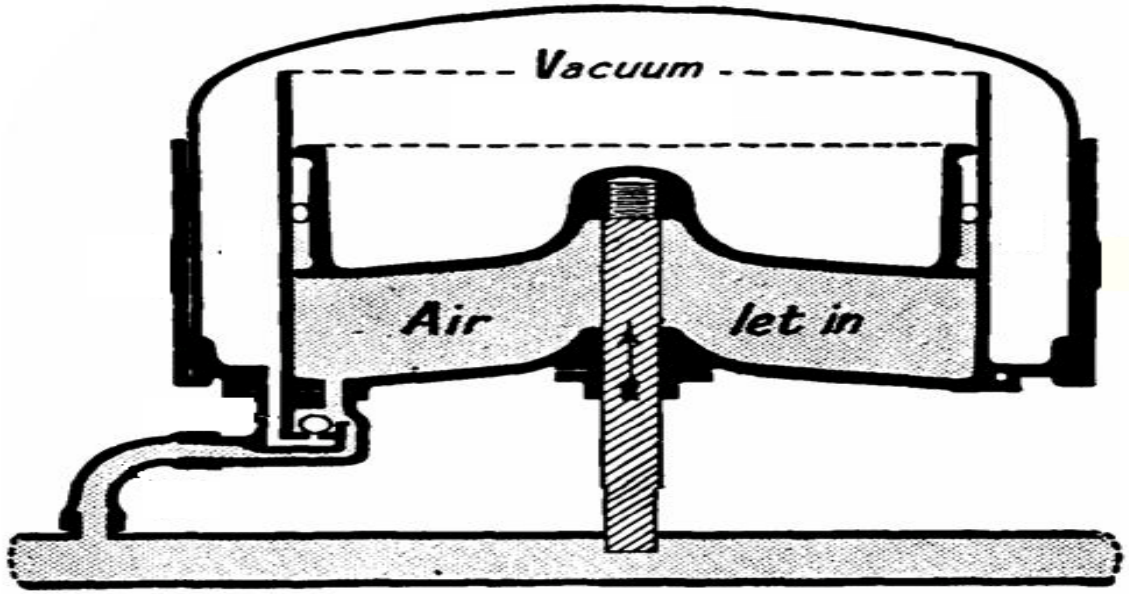
Introduction to Vacuum Brake System:

- A major advance was the adoption of a vacuum braking system, in which flexible pipes were connected between all the vehicles of the train, and brakes on each vehicle could be controlled from the locomotive.
- The earliest scheme was a simple vacuum brake, in which vacuum was created by operation of a valve on the locomotive; the vacuum actuated brake pistons on each vehicle, and the degree of braking could be increased or decreased by the driver.
- Vacuum, rather than compressed air, was preferred because steam locomotives can be fitted with ejectors venturi devices that create vacuum without moving parts.

Working Principle of Vacuum Brake System Used in Indian Railways:

- The vacuum brake system derives its brake force from the atmospheric pressure acting on the lower side of the piston in the vacuum brake cylinder while a vacuum is maintained above the piston.
- The train pipe runs throughout the length of the coach and connected with consecutive coaches by hose coupling.
- The vacuum is created in the train pipe and the vacuum cylinder by the ejector or exhauster mounted on the locomotive.


Vacuum Chamber
Cylinder
(Vacuum)
rolling rubber ring
Piston
Ball Valve
(Vacuum)
Rod working brake-levers
Train Pipe
(Vacuum)


Vacuum
Air
let in

Components of vacuum brake systems:

- Train pipe -- single pipe.
- Vacuum brake cylinder- 24" type 'F‘.
- Alarm chain apparatus.
- Clappet Valve.
- Guard's Van Valve.
- Slack Adjuster.
- Direct Admission Valve.
- Hose coupling for train pipe.
- Vacuum reservoir 320 litre capacity.

- Pressure:
  1. Effective pressure on piston - 0.kg/cm^2
  2. Nominal vacuum on train pipe-510mm.
  3. Vacuum Brake works on atmospheric pressure at 1.03 kg/$cm^{2.}$

- Pipe diameter:
  Train pipe - & 50 Bore.

Limitations of Vacuum Brake:

- Vacuum brakes are less effective at high altitude.
- This is because they depend upon the creation of a pressure differential; atmospheric pressure is lower at high altitudes, and so the maximum differential is also lower.
- Hence Air Brake System is Introduced in Indian Railways.

Working Principle of Air Brake System Used in Indian Railways:

- The compressed air is used for obtaining brake application.
- The brake pipe and feed pipe run throughout the length of the coach.
- Brake pipe and feed pipe on consecutive coaches in the train are coupled to one another by means of respective hose couplings to form a continuous air passage from the locomotive to the rear end of the train.
- The compressed air is supplied to the brake pipe and feed pipe from the locomotive.
- The magnitude of braking force increases in steps with the corresponding reduction in brake pipe pressure and vice-versa.

Types of Air Brake System in Railways:

- Direct Release System :- (100% creation & drop of pressure) In direct release system, the brake cylinder pressure cannot be reduced in steps by increasing the brake pipe pressure in steps during release. The brakes are released immediately, as soon as releasing of brakes is initiated.
- Graduated Release System:-

  In this system the brake cylinder pressure can be reduced gradually in steps in proportion to the increase in brake pipe pressure.

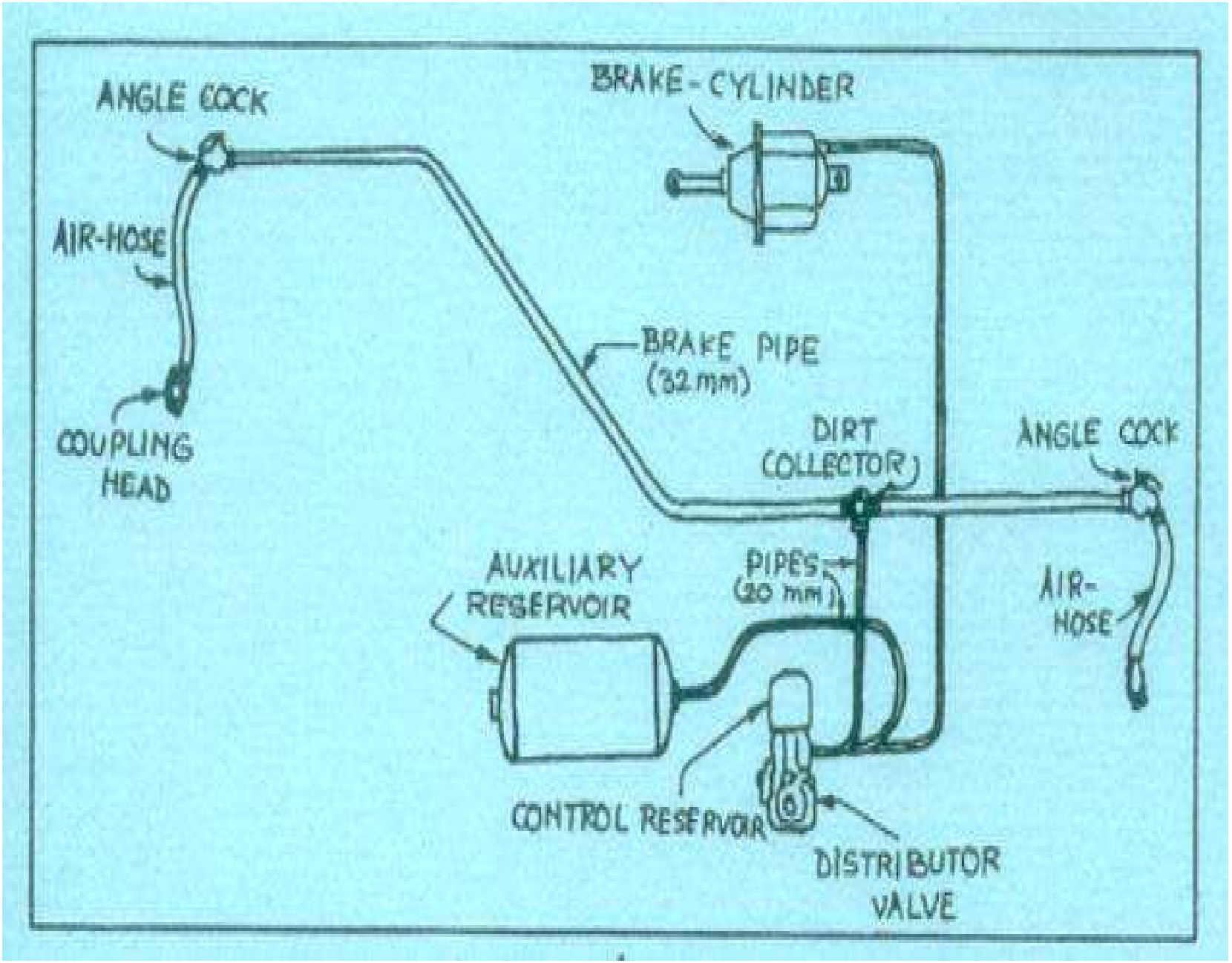
  NOTE: - In both types of the system brake application is directly proportional to the reduction in brake pipe pressure.

There are two types of Graduated Release Air Brake:-

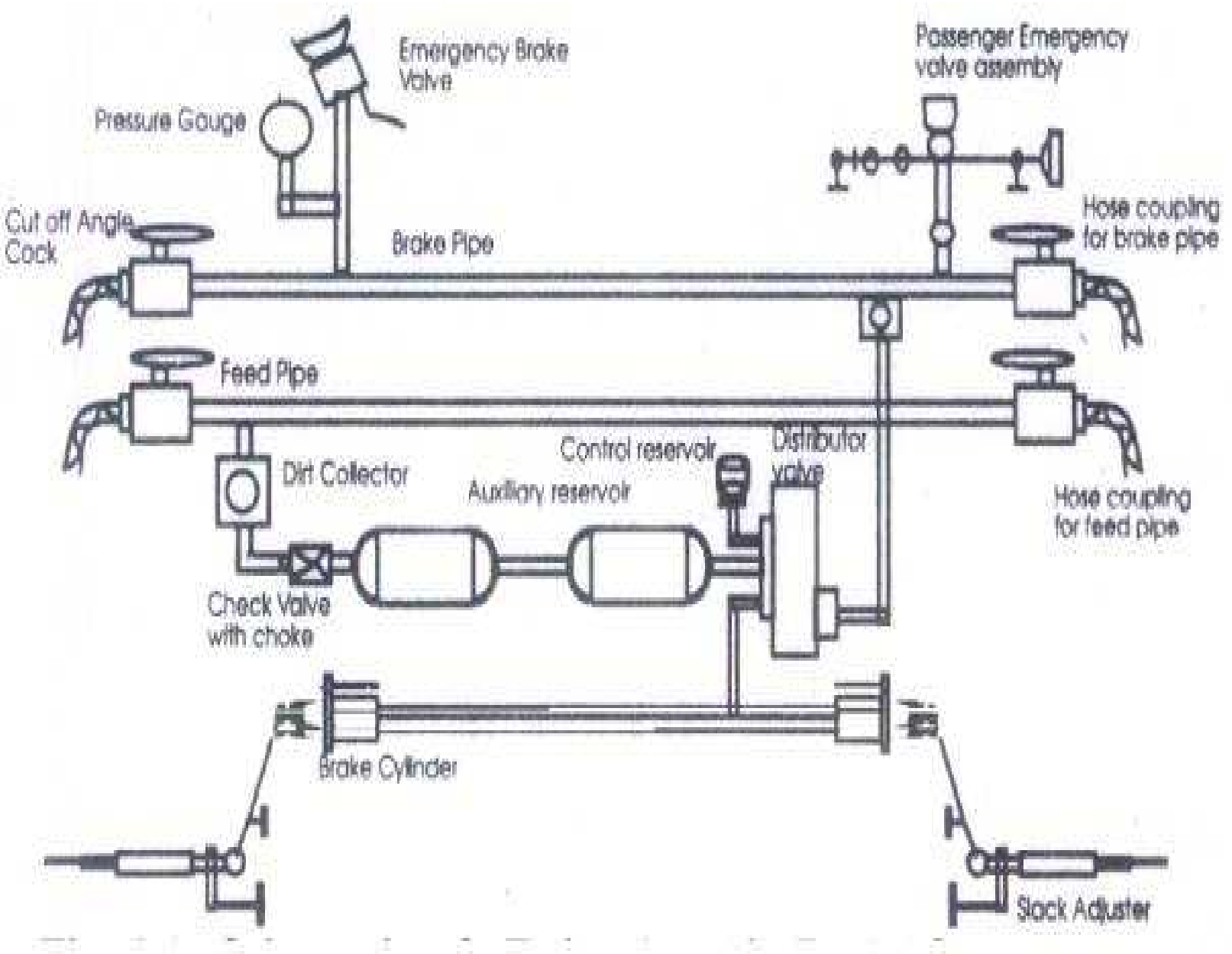
- Single Pipe Air Brake System:

  There is only one pipe called brake pipe running from loco to the brake van in order to get continuity of air for the application & release of brakes.

  - At present running in goods stock.(Except latest developed BOX-N HL, BCN HL wagons)
  - Releasing time is more 45 to 60 sec.


ANGLE COCK
BRAKE - CYLINDER
AIR-HOSE
BRAKE PIPE
(32 mm)
COUPLING
HEAD
DIRT
COLLECTOR
ANGLE COCK
AUXILIARY
RESERVOIR
PIPES
(20 mm)
AIR-
HOSE
CONTROL RESERVOIR
DISTRIBUTOR
VALVE

- Twin Pipe Air Brake System :-
  - In addition to brake pipe, there is one more pipe called feed pipe , running loco to the brake van to charge the auxiliary reservoir continuously to 6 kg/cm^2.
  - At present running in coaching stock and also in latest developed BOX-N HL, BCN HL wagons)
  - Releasing time is less 15 to 20 sec


Emergency Brake Valve
Pressure Gauge
Passenger Emergency valve assembly
Cut off Angle Cock
Brake Pipe
Hose coupling for brake pipe
Feed Pipe
Dirt Collector
Control reservoir
Auxiliary reservoir
Distributor valve
Hose coupling for feed pipe
Check Valve with choke
Brake Cylinder
Slack Adjuster

Components of Air brake systems

- Brake pipe and feed pipe (twin pipe system for coaching stock, single pipe system for goods stock).
- Air brake cylinder –355mm diameter *(Pressure max. 3.8 ± 0.1 kg/cm^2)*
- Distributor Valve.
- Passenger Emergency Alarm Signal Device.

- Passenger Emergency Valve.
- Guard's Emergency Valve.
- Slack Adjuster.
- Hose coupling for brake pipe and feed pipe.
- Auxiliary reservoir 100 lit capacity for Wagons & 200 Lit for Coaching Stock.
- Cut off Angle cock.
- Check valve with choke.
- Dirt collector.

- Pressure:
  Effective cylinder pressure = 3.8kg/cm^2
  Feed pipe - 6kg/cm^2
  Brake pipe - 5kg/cm^2

- Pipe diameter:
  Feed pipe - & 25mm Bore
  Brake pipe - & 25mm Bore

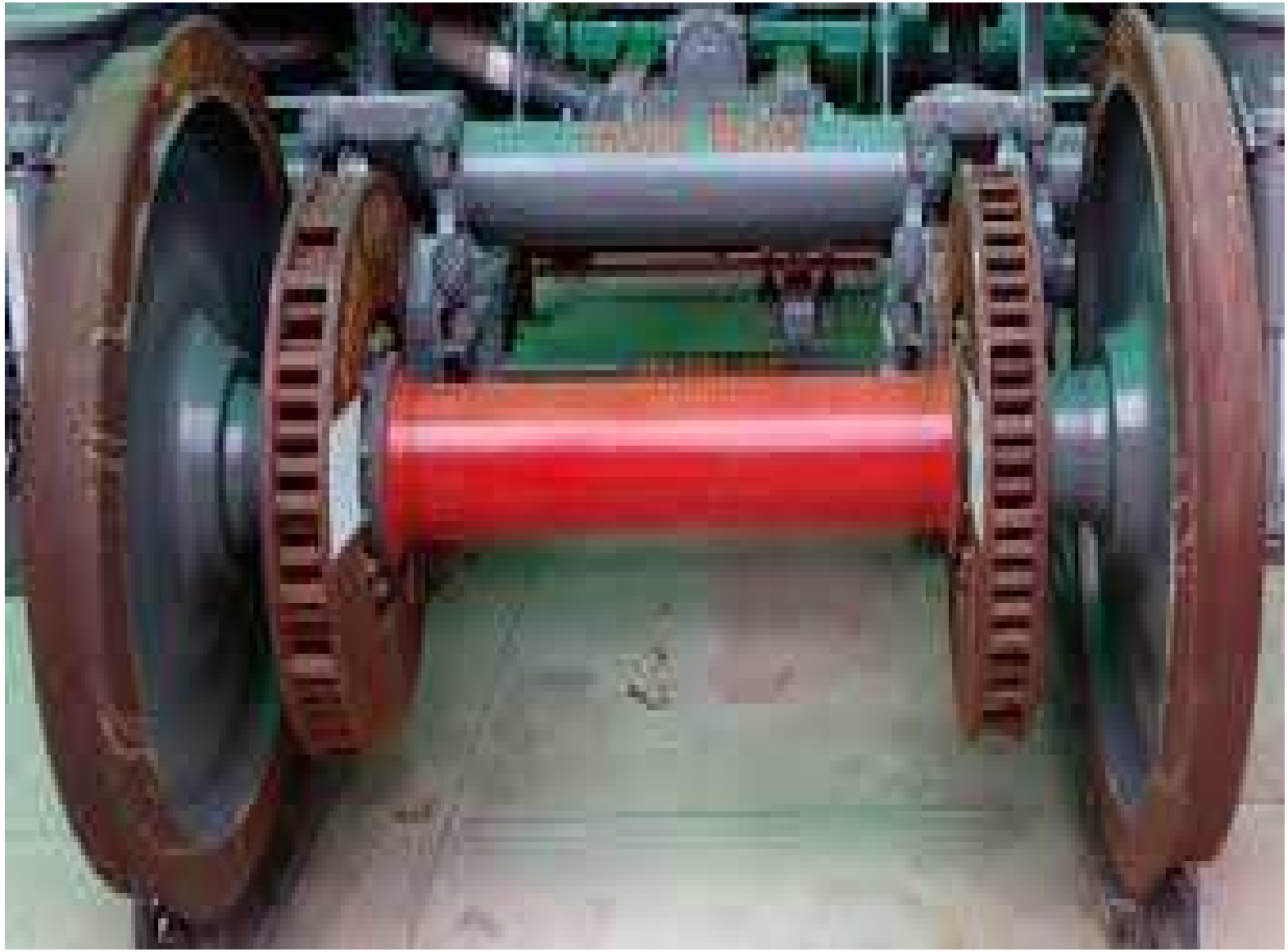
Advantages of Air brakes over Vacuum brakes

S No.	Parameters	Air Brakes	Vacuum Brakes
1	Emergency braking distance (4500 t level track, 65 kmph)	632m	1097m
2	Brake power fading	No fading	At least by 20%
3	Weight of equipment per wagon (approx.)	275kg	700kg
4	Pressure Gradient	No appreciable difference in air pressure between locomotive and brake van up to 2000m.	Steep reduction in vacuum in trains longer than 600m.
5	Preparation time in departure yards (45 BOX or 58 BOXN)	Less than 40 minutes.	Up to 4 hours.
6	Safety on down gradients	Very safe	Needs additional precautions
7	Overall reliability	Very good	Satisfactory

DISC BRAKE SYSTEM:

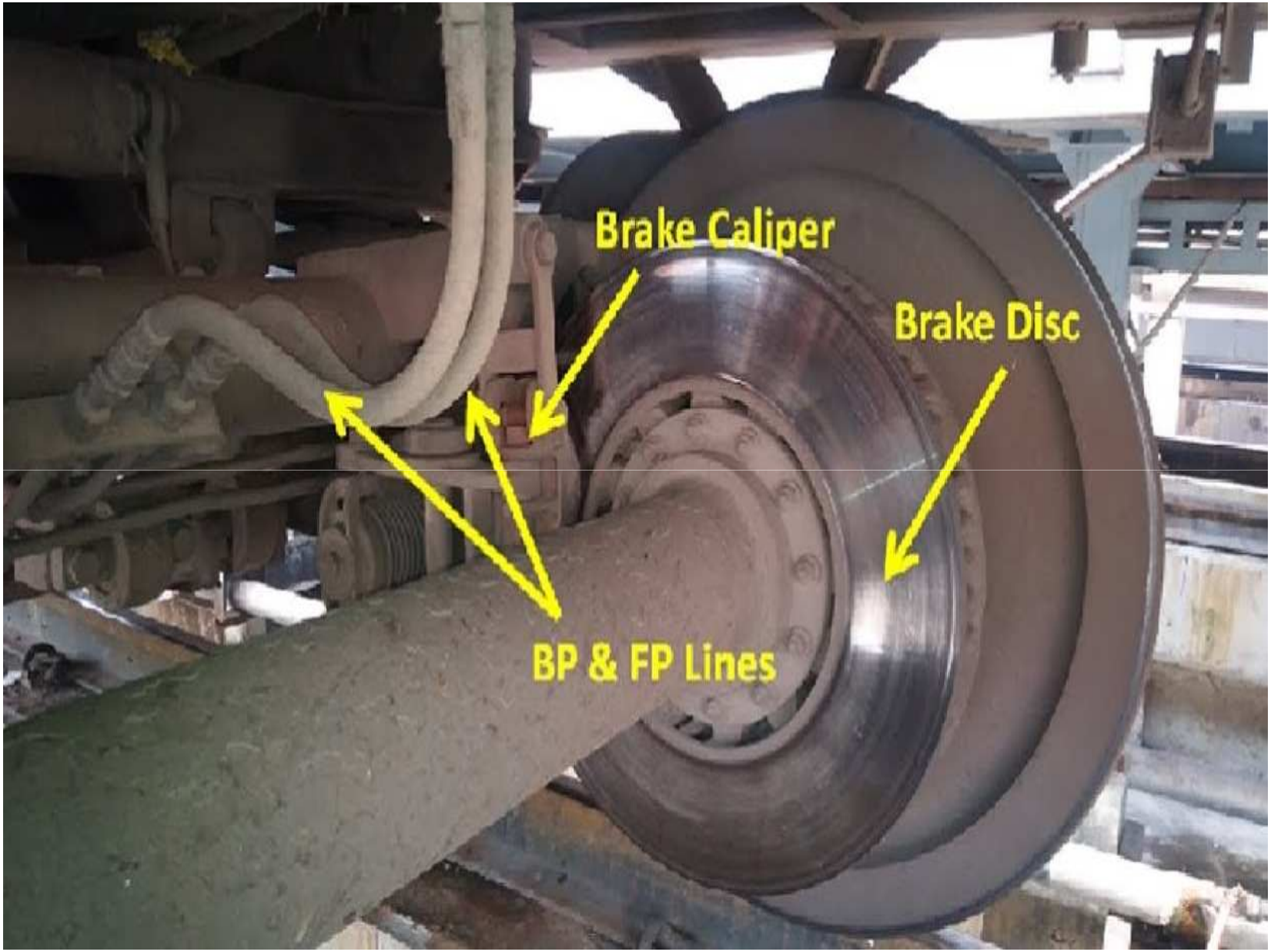
- Axle Mounted Disc Brake System is being utilized in LHB type coaches equipped with FIAT types of bogies.
- In this types of brake system 2 nos. disc (640mm dia and 110 mm width) per axle are mounted.
- To actuate brake on each disc, Brake calipers (with brake pads of dia 35 mm) are mounted on bogie with 10’ dia brake cylinder.

Axel Mounted Disc Brake System



Working Principle of Axel Mounted Disc Brake System:

- The basic principle of axle mounted disc brake system is similar to conventional air brake system but the difference is only that the breaking occurred on discs instead of wheel trade in conventional system.
- As per Reduction of pressure in BP simultaneously pressure rises in brake cylinder and brake actuator actuates the brake pads which clasps with brake disc.
- As the discs are mounted on axle resulting wheels to stop.


Brake Caliper
Brake Disc
BP & FP Lines

MAIN COMPONENTS OF DISC BRAKE SYSTEM:

- Control Panel Bogie Equipments
- Anti-skid system.
- Flex ball cable arrangement (for parking brakes)(Used only for Generator & SLR coaches).

CONTROL PANEL CONSISTS

- Distributor valve with suitable relay valves.
- Control reservoir.
- Air reservoirs – 2 nos. – 125 liters: for Air Brake- 75 liters: for Toilet System Stopcock – 2 nos. (For Bogie isolation)
- Isolating cock – 2 nos. (For F.P. & Toilet circuits)
- Filter (Dirt Collector) – 2 Nos.
- Check valve.
- Test fitting – 4 nos (B.P., F.P., B.C. & C.R.)
- Pressure switch.

BOGIE EQUIPMENT CONSISTS:

- Brake Disc.
- Brake Caliper Unit comprising of Brake Cylinder.
- Brake Caliper.
- Brake Pads.
- Indicators
- Emergency Brake Accelerators with cock.
- Emergency brake cable pull box.
- Emergency brake valve.
- Angle cock
- Brake hose coupling (F.P. & B.P.).

ADVANTAGES of Disc Brake System:

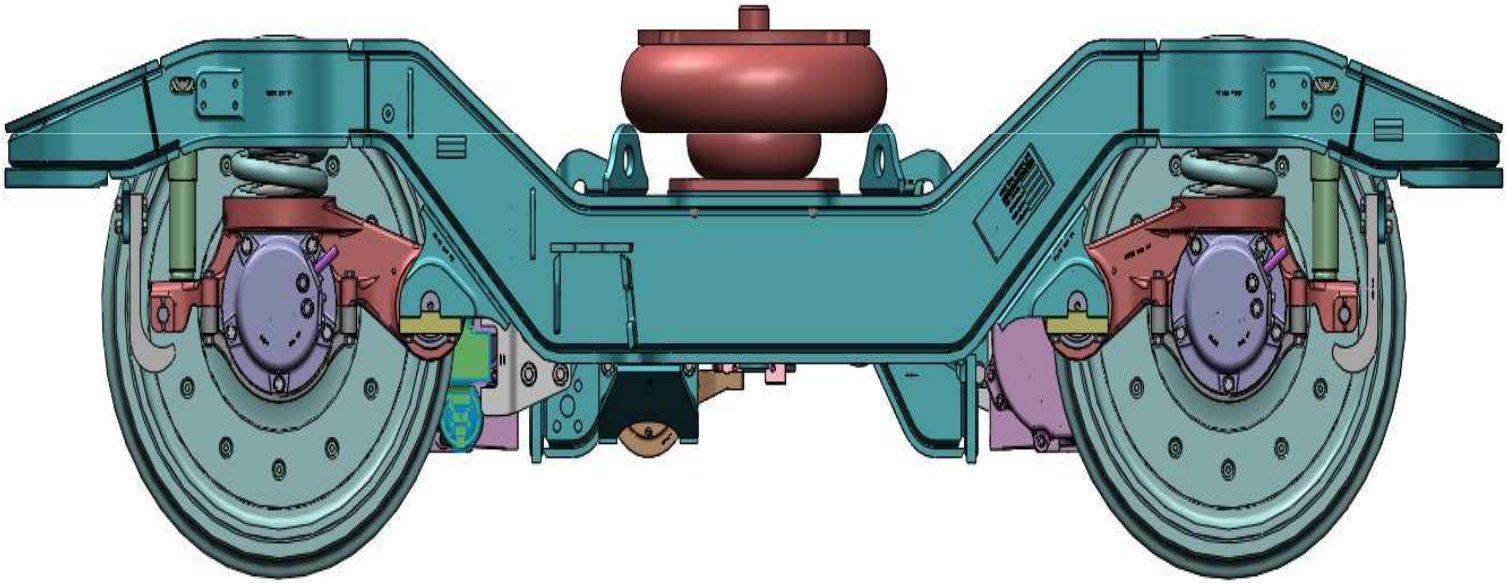
- Reduction in wheel wears resulting the increase in wheel life.
- Fewer chances of wheel skidding due to break binding as WSP system is adopted.
- The coefficient of friction is increased (i.e. 0.35) resulting from better braking.
- Better controlling of the train due to the fitment of actuator valve which senses faster brake application and reduces the braking time in entire rake.(Braking distance is only 1200 m with 18 coaches and 160 kmph speed.)

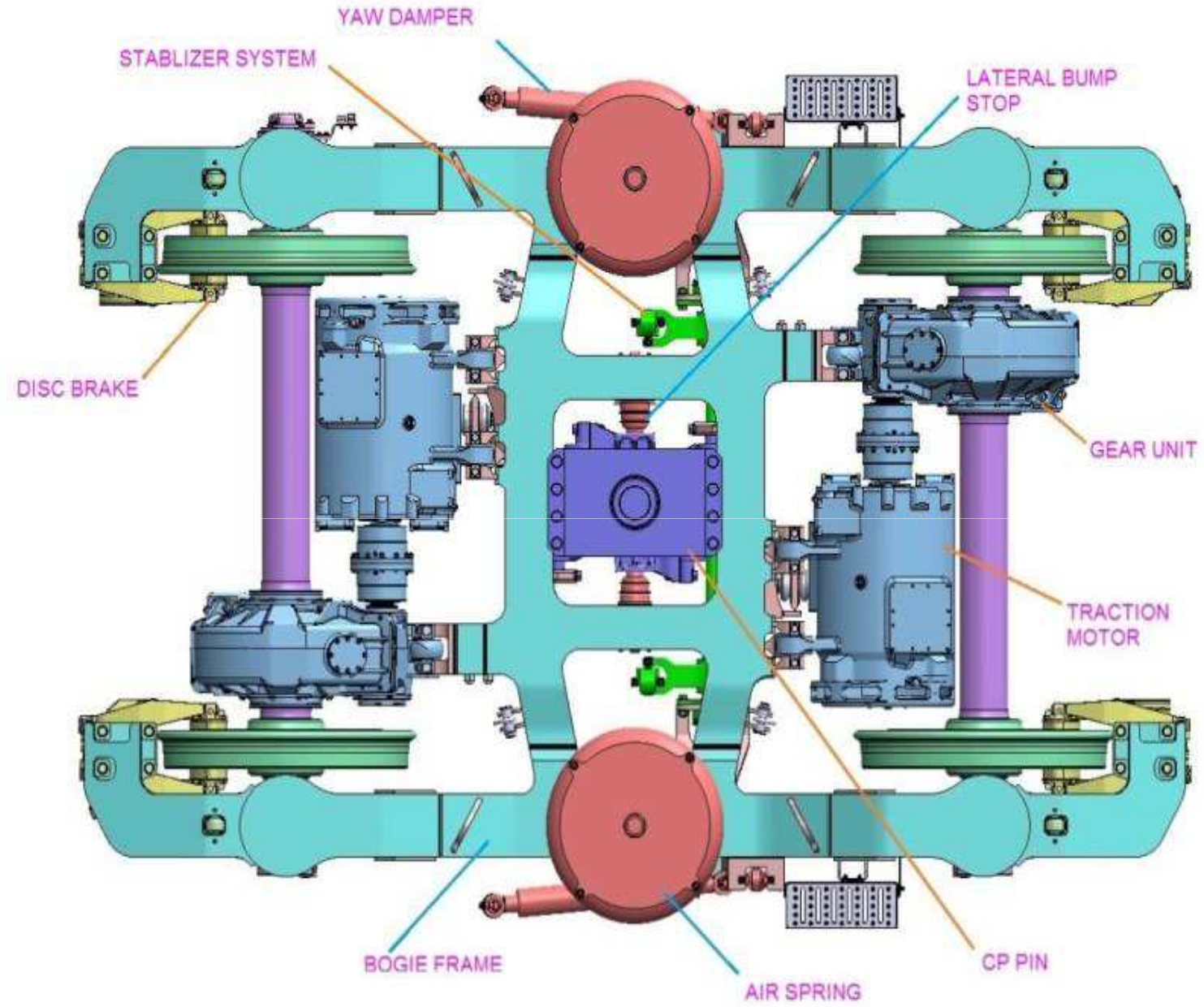
- The quick application of brake through ACP as the choke dia is increased from 08 mm to 19 mm.
- Direct Isolation of the main component i.e. DV, CR, BC, AR etc is possible through the control panel.
- Provision of standby cut off angle cock of BP and FP resulted enroute trouble can be tackled easily.

Electro-Pneumatic Brakes

- It is the latest Braking System used in sub urban trains & Modern Train sets like T-18(Vande Bharat Express).
- It provides quick and effective braking.
- Wheel mounted disc brake system for better reliability, space utilization and less maintenance.

Wheel Mounted Disc Brake




YAW DAMPER
STABLIZER SYSTEM
LATERAL BUMP STOP
DISC BRAKE
GEAR UNIT
TRACTION MOTOR
BOGIE FRAME
AIR SPRING
CP PIN

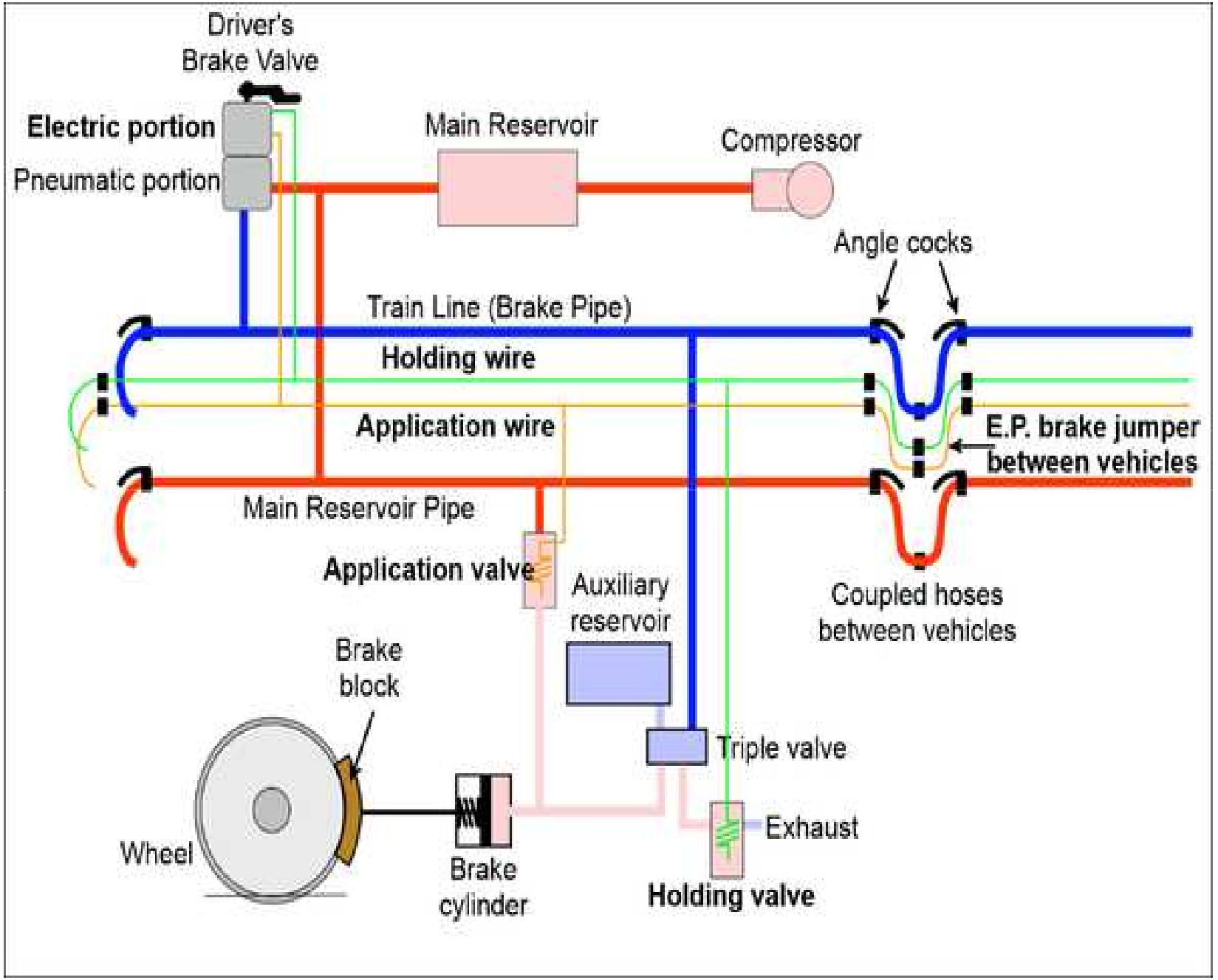
EP Brake Control:

- Electro-Pneumatic brakes are controlled by the driver's brake valve handle. It is usually the same handle used to control the air brake.
- Electrical contacts are provided so that selection of a position will energise the train wires required to operate the e-p valves on each car.
- Current to operate the brake control is supplied from a battery through a control switch, which is closed in the operative cab.

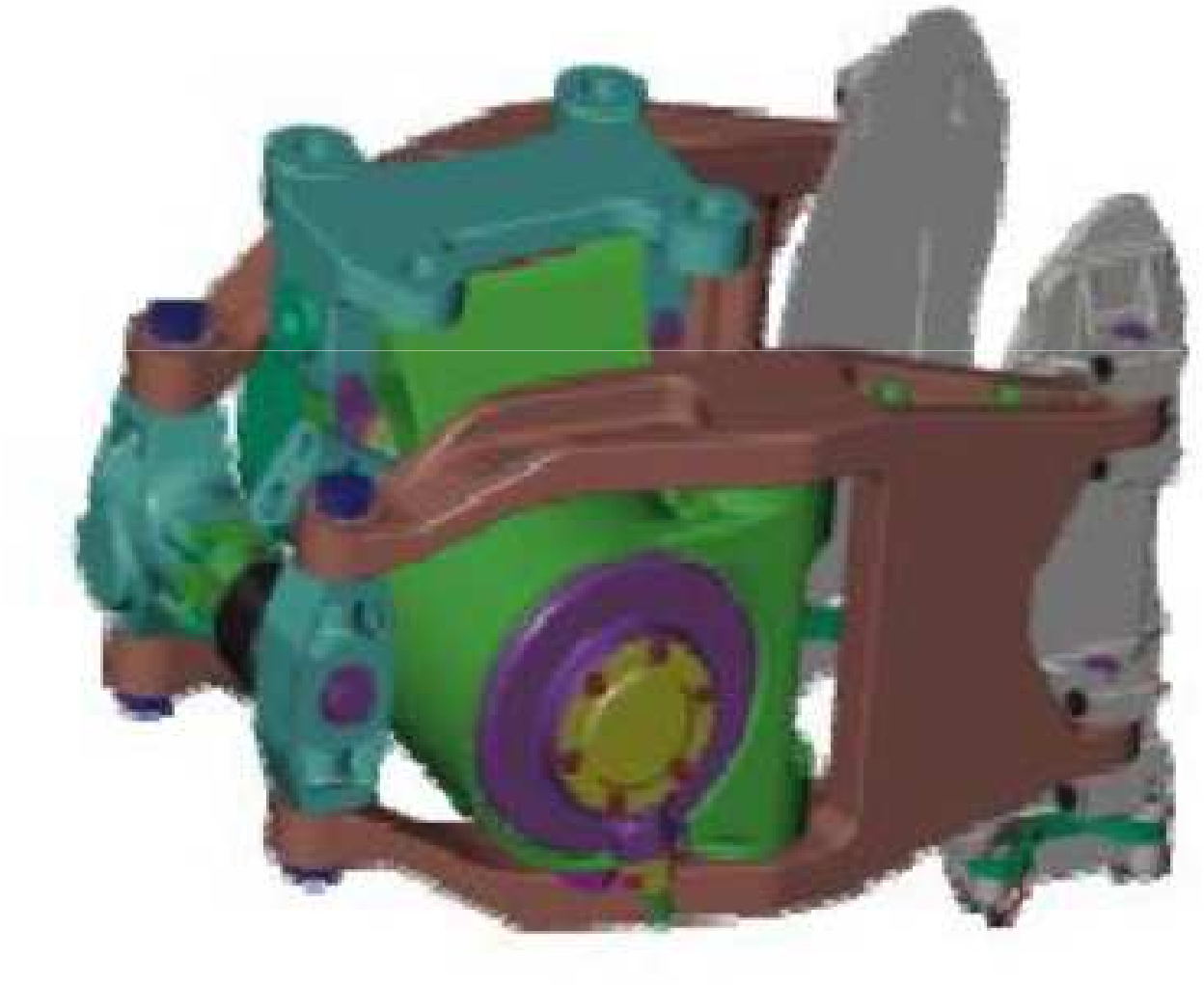
Principles of the E-P Brakes:

- The e-p brake operates as the service brake while the air brake is retained for emergency use.
- The e-p brake does not compromise the fail-safe or "vital" features of the air brake.
- The air brake normally remains in the "Release" position, even while the e-p brake is in "Application" and the same brake cylinders are used.

- E-P brakes are invariably used on multiple unit passenger trains.
- E-P brakes use a number of train wires to control the electrically operated brake valves on each car.
- The train wires are connected to a brake "valve" or controller in the driver's cab.


Driver's
Brake Valve
Electric portion
Pneumatic portion
Main Reservoir
Compressor
Angle cocks
Train Line (Brake Pipe)
Holding wire
Application wire
E.P. brake jumper
between vehicles
Main Reservoir Pipe
Application valve
Auxiliary
reservoir
Coupled hoses
between vehicles
Brake
block
Triple valve
Exhaust
Wheel
Brake
cylinder
Holding valve

Compact Brake Calliper



These Modern High speed Train sets are the future of the Indian Railways

- These Train Sets are using modern wheel mounted Electro Pneumatic disc brakes system.

- This is how the Railway Braking System is developed by the time.

THANK YOU