COUPLERS BOGIE AND AIR SUSPENSION OF EMU/DEMU

COUPLERS

COUPLERS OF EMU/DEMU

Role of Couplers

- To Provide
  - Flexibility to Individual Rolling Stock
  - Transmit the Pulling Force
  - Provide Buffing at the time of Braking
- Requirement
  - To withstand
    - The Buffing Force and Pulling Force
  - To facilitate Side/Vertical Displacement
    - To Coach Body at
      - Curve & Elevation Change

COUPLERS OF EMU/DEMU

Schaku Couplers

- Original Scharfenburg Kupplung, GmbH
  - Designed in 1903 in Germany
- Most Widely used in
  - Mass Transit System around the world
- Semi Permanent Coupler
  - End A
  - End B

SCHAKU COUPLERS FEATURE

Tensile Load 70T Max.

Compressive Load 100 T Max.

Rigid Connection with Negligible Play

No Appreciable Wear & Tear during Train Operation

No Slack means No Jerk

Rubber Steel Composite Draft Gear Capacity 800 Kg-M

SCHAKU COUPLERS FEATURE

Fulcrum of Coupler Located Far

- Allows Side Displacement of Coaches & Couplers
  - At Curves
    - Reducing the Lateral Force On Wheels
    - Less Wear
    - Less Prone to Derailment

SCHAKU COUPLERS FEATURE

Pivot Joint between Coach and Coupler permits
- Horizontal Deflection 284mm/13° either side
- Vertical Deflection of ±75 mm
- Achieved by Articulation Bearing

Interlocking in Vertical Direction
- Prevents Climbing of
  - One Coach over Other
    - In Case of Accident

SUB-ASSEMBLIES

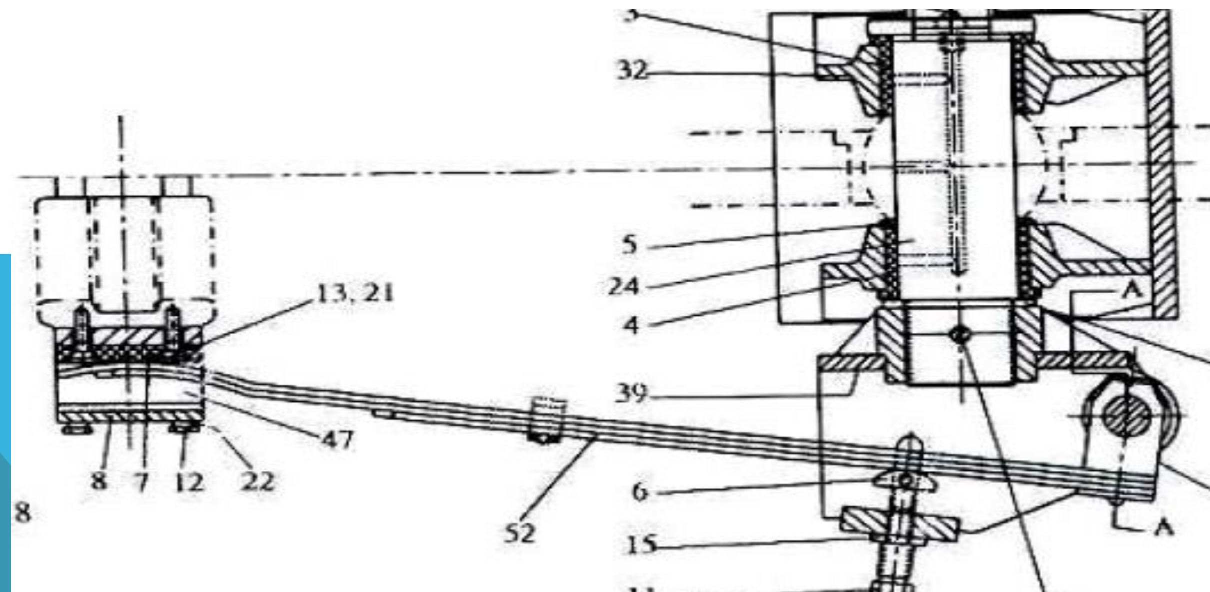
Semi Permanent Coupler Consist of

Bearing Bracket with Support -	End A&B
Draw and Buffer Gear -	End A&B
Intermediate Tube -	End A&B
Air Pipe Coupling -	End A&B
Center Adjustment Device -	End A&B
Centering Device -	End A Only
Centering Device -	End B Only
Adjustable Cup sleeve –	End A only

SUB-ASSEMBLIES

Bearing Bracket with Support - End A&B

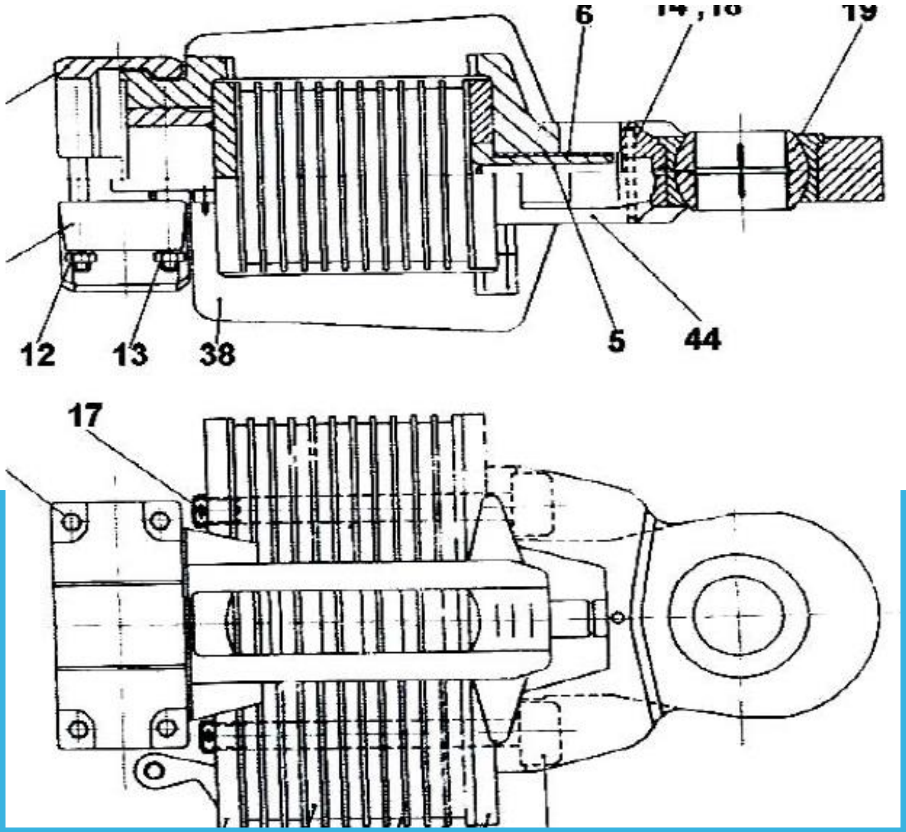
Fixed into End Part of Coach
Houses Two Concentric Bushes
Connected to Articulation Bearing
Leaf Spring Holding Device
Leaf Springs to support Overhanging Coupler



SUB-ASSEMBLIES

Draw and Buffer Gear - End A&B

- Rubber Spring and Steel Plate
  - Always in Compression
- Fabricated Yoke housing
  - Rubber Spring
  - Plates
  - Articulation Bearing
- Connected to
  - Bearing Bracket and
  - Intermediate Tube



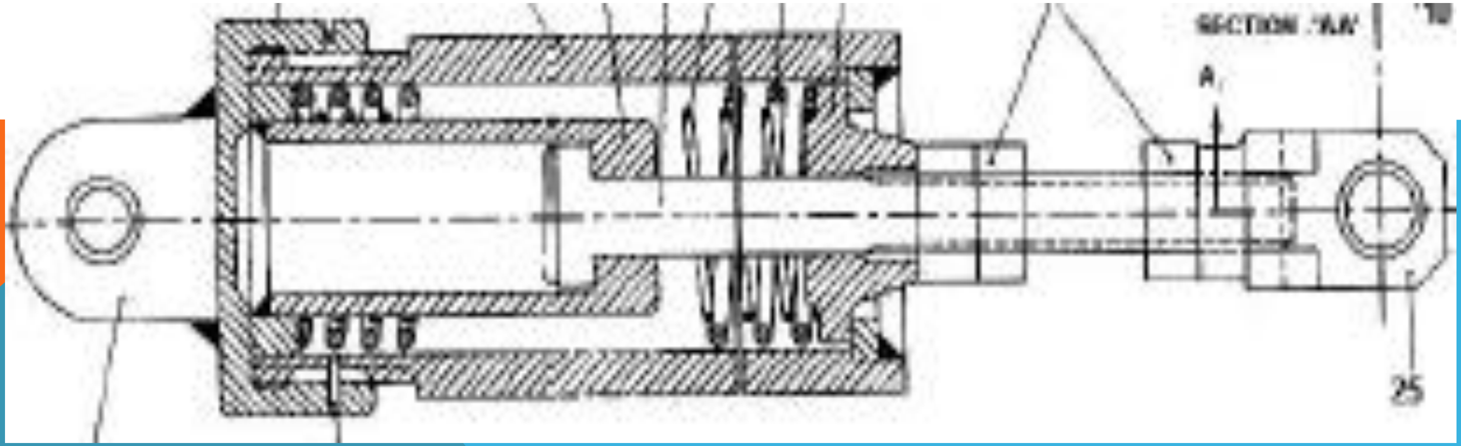
SUB-ASSEMBLIES

Center Adjustment Device - End A&B

Two Concentric Helical Compression Springs
in Barrel with Clevis End

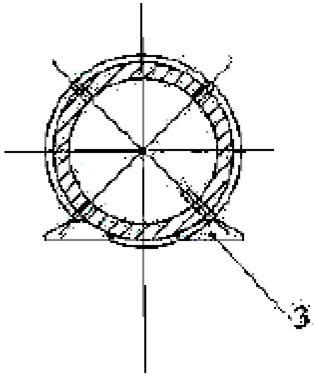
Facilitate Mounting into Underside of Frame

Exert Storing Force to keep
Coupler End in Central Position



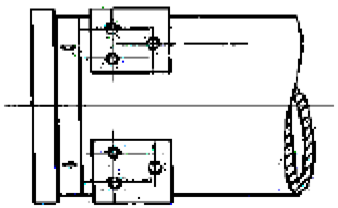
SUB-ASSEMBLIES

Intermediate Tube - End A&B



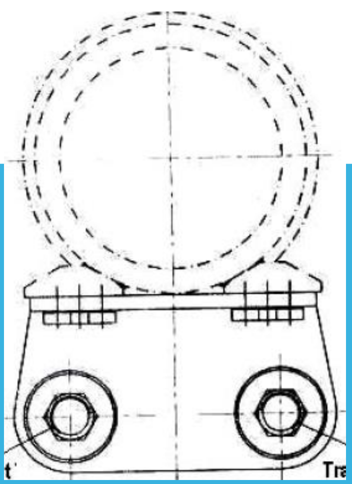
Two Forged Ring welded on Seamless Tube

Single Solid Stock extending from Articulation Bearing



Air Pipe Coupling - End A&B

Fabricated Structure houses Mounting for MR Pipe and Brake Pipe



SUB-ASSEMBLIES

Adjustable Cup Sleeve - End A only

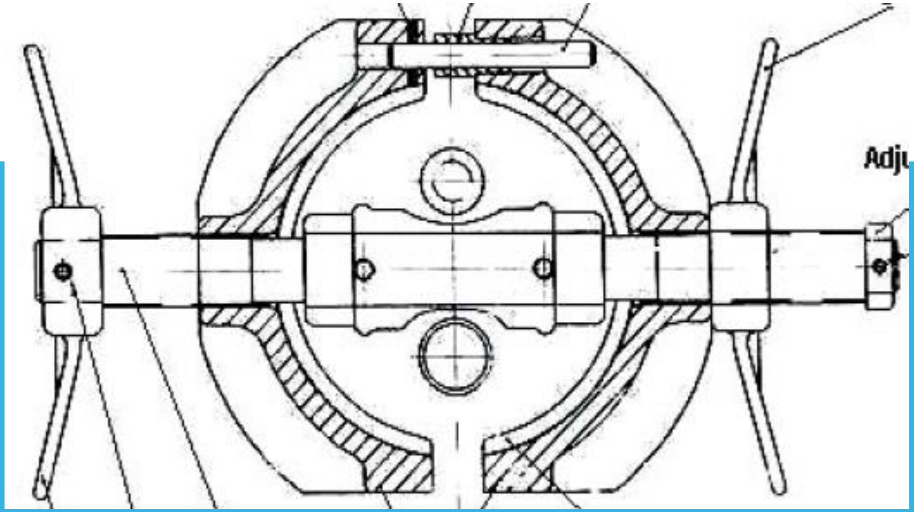
Mounted on Outer Part of Intermediate Tube End A

Two-semi Circular Sleeve with Tapered Slot

Sleeves Adjustment in Position by Spindle

Forming Rigid Connection

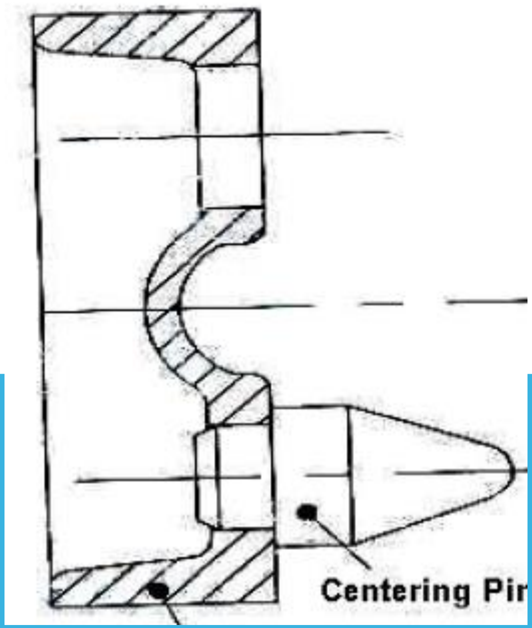
Exact Centering done by Guide Pin



SUB-ASSEMBLIES

Centering Device - End B Only

Circular Disc Type Forging with Guide Pins Forms Coupling Face of Intermediate Tube End A&B



MAINTENANCE - COUPLERS

Polyamide Bush

Replacement at POH

Draft Gear

Height in Unrestricted Condition

Intermediate Tube

DPT of Welded Joints

Cup Sleeve

Wear Check by Gauge

Bearing Bracket

Wear Check by Gauge

Check for Cracks

BOGIE

BOGIE OF EMU/DEMU

All Welded Light Weight Bogie

Axles with Self Aligned Spherical Roller Bearing

Guided Rigidly by

Telescopic Axle Guide Dash Pot Arrangement

Helical Spring as Primary Suspension

Supported on Side Bearers

DPC – 1200 mm apart

TC – 1600 mm apart

BOGIE OF EMU/DEMU

Floating Bolster resting on

Pair of Air Spring as Secondary Suspension

Rest on Lower Spring Beam

Vertical and Lateral Shock Absorbers

To damp Vibrations Lateral/Vertical

Centre Pivot

Facilitate Rotation of Bogie

Transmit Tractive/Braking Force

Securing of Floating Bolster

in TC by Anchor Link

in DPC – Between Bogie Transom

MAINTENANCE - BOGIE

Bogie Frame

- DPC - DMU/DPC5-0-0-501
- TC - DMU/TC4-0-0-401
- Axle Guide Brackets Welded

Lower Spring Beam

- Welded Joint & Corrosion

Rubbing Plate in DPC

- Provided between Bolster and Bogie
- Serve as Pad
- Nylon or Manganese Steel
- Clearance to be maintained

MAINTENANCE - BOGIE

Wheel Diameter

	New	Condemning	Last Shop Issue
DPC	952 mm	877 mm	885 mm
TC	915 mm	813 mm	837 mm

Permissible Variation in Wheel Tread Dia

Same as ICF Coach

Axle Bearing

Self Aligning Spherical Roller Bearing

DPC - EMU/M-0-2-001

TC - WTAC3-0-2- 304

MAINTENANCE - BOGIE

Centre Pivot

- Bent Wear Crack
- Chalk Test/DPT
- Loose/Missing Mounting Bolts

Side Bearers

- Hard Wearing Ground Steel Plate
- Bronze Wearing Piece
- Oil Bath
- Dust Seal Cover
- Replenishment of Oil

MAINTENANCE - BOGIE

- Traction Motor Removal
  - Electrical Manual No. MM/DC EMU.003
- Shock Absorber
  - Vertical – DMU/DPCS-0-5-503
  - Lateral - DC/EMUM/ASR-0-5-005
  - Testing
- Brake Gear
- Axle Guide
  - Guide Bush
- Bogie Bolster
  - Centre Pivot Silent Block and Sleeve

MAINTENANCE - BOGIE

Coupler Height Adjustment

Buffer Height of DPC – 1105 mm +0/-15

Schaku Coupler Height - 1035 mm +0/-15

Air Brake

Brake Cylinder Piston Stroke

DPC – 40 mm TC – 32 mm

Brake Cylinder Pressure

DPC – 1.6 kg/cm^2

POH Periodicity – 18 Months

AIR SPRING SUSPENSION

AIR SPRING

Air Spring
- A Column of Confined Air in
  - A Container Designed to
    - Utilize the Compressed Air as
      - A Medium of Transmitting Force.

Ability of Air Spring to Support a Mass
- Depends on its Effective Area
- Pressure

Stiffness of Air Spring Depends on
- Change in Effective Area
- Change in Air Pressure

TYPES OF AIR SPRINGS

Locked-In System Springs

- Having a Constant Mass of Air
  - Not Connected with Any Air Source
- The Natural Frequency
  - Increases with Load

Active-Air System Springs

- Connected to a Constant Source of Air
  - Through Height Control Valve Arrangement
- Fairly Uniform Natural Frequency

COMPRESSION PROCESSES

Isothermal Process

A Constant Temperature Process

Possible when Compression takes place

in infinitesimally small steps

Minimum Stiffness

most desirable

but practically not possible

COMPRESSION PROCESSES

Adiabatic Process

- Occurs during very rapid deflection
  - Maximum Stiffness

Polytropic Process

- The Most Practical One
  - Lies between the Previous Two

MECHANICAL MODEL

Pressure of Spring Po =Pat+Pabs

Force on spring F=(Po-Pat)Aeff=Pabs*Aeff

Differentiating with respect to deflection

dF/dz = Aeff*dPo/dz + Pabs*dAeff/dz ....(1)

For Polytropic Process PV**n = Constant

(V**n)dPo/dz + Po*n*V**(n-1)dV/dz = 0 .. (2)

dPo/dz = - {Po*n*V**(n-1)/v**n}dV/dz

= Po*n*Aeff/V

MECHANICAL MODEL

Substituting dPo/dz in (1)

Stiffness K =

(Po*n*Aeff**2)/V + Pabs*dAeff/dz

n is polytropic index and z is the deflection

This can be approximated as K =K1 + K2

K1 is stiffness due to change in pressure

K2 is stiffness due to change in effective area

AIR SPRING ON IR

Active System an Enclosed Pressurized Air in
Predefined Chamber of
Rubber Bellow with
Emergency Rubber Spring

Air Bellow fitted Between Two Plates
Air Pressure Creates Gap between
Plates Provides Cushioning

AIR SPRING ON IR

Emergency Rubber Spring
- Comes in Operation upon
  - Deflation of Bellow
  - During Overload

Requires Compressed Air 7 kg/cm^2

Able to support Maximum Load with
- Air Pressure inside Bellow 5.5-5.8 kg/cm^2

Failure/Deflation/Heavy Leakage of Air Spring
- Train can move at 50 kmph

CONSTRUCTION

1.1 Airspring assembly description

Airspring system is composed of Top plate, air bellow, emergency spring and sliding plate and fasteners and O-rings. For details please see Fig1 and Table1.

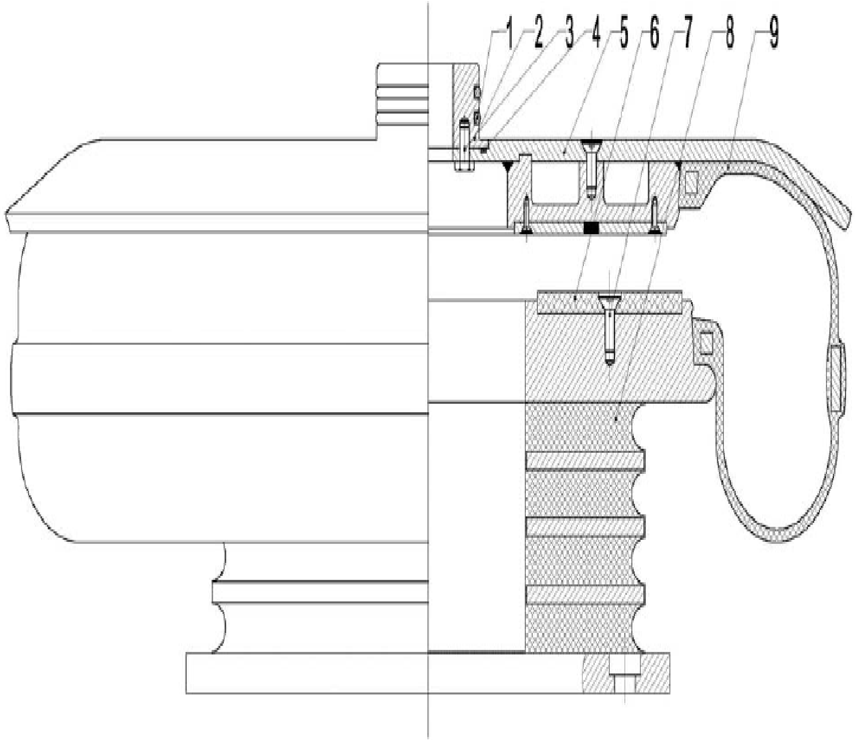


Fig1 C-K509 airspring sketch

Table 1: Part list for ck509 airspring

Part	Parts name	Part number	Weight (Kg)	Quantity per unit
1	O-ring	GB3452.1 75×5.3	0.1	2
2	Air inlet	C.KH060400301	5	1
3	Hexagon socket head cap screws	GB/T 5786-2000 M8×16	0.2	4
4	O-ring	GB3452.1 87.5×3.55	0.05	1
5	Top plate	C.KH060400300	42.5	1
6	Sliding plate	C.KH060400500	1.25	1
7	Hexagon socket head cap screws	GB/T 70.3 M8×20	0.3	6
8	Emergency spring	C.KH060400200	90.5	1
9	Air spring bellow	C.KH060400100	11.25	1

AIR SPRINGS – WORKING PRINCIPLE

The Fundamental Principle

Mass of Compressed Air in
Predefined Rubber Bellow
Exerts a Force (Kinetic Theory of Gases)
Functions as Suspension Element
Dynamic Forces are taken care by
Changes in Internal Pressure
Air Spring Effective Area
According To Height Variation

AIR SPRINGS – WORKING PRINCIPLE

The Fundamental Principle (Contd…)

When Load Added or Removed

- Leveling Valve Operates to
  - Add or Remove Sufficient Air
    - To Maintain Set Height of Air Spring

The Overall Vertical and Lateral Characteristics

- Depends Upon
  - The Pressure and Volume of Air
  - Shape and Size of Air Bellows
  - Properties of Air Used i.e. Polytropic Index.

AIR SPRINGS – WORKING PRINCIPLE

The Fundamental Principle (Contd...)

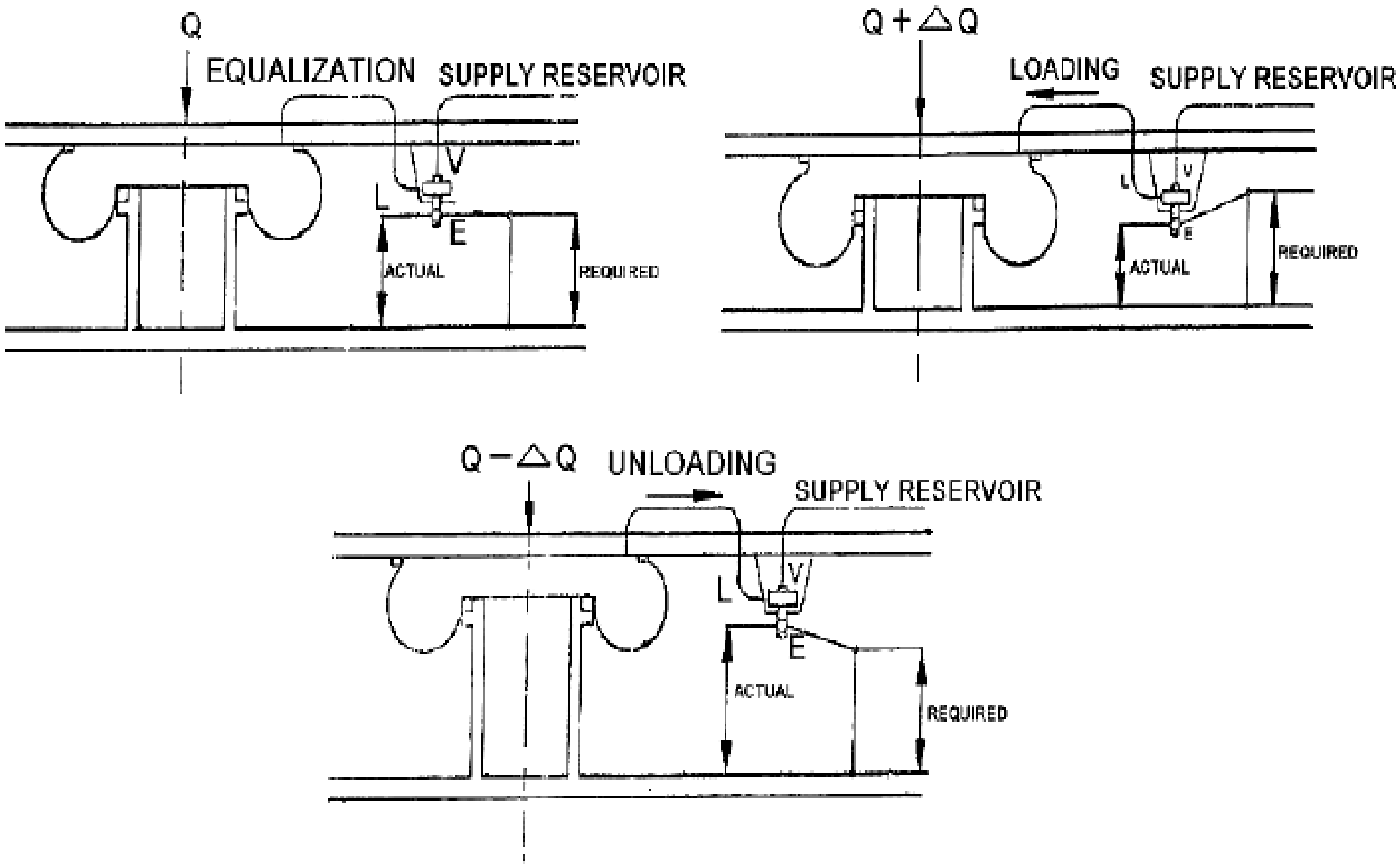
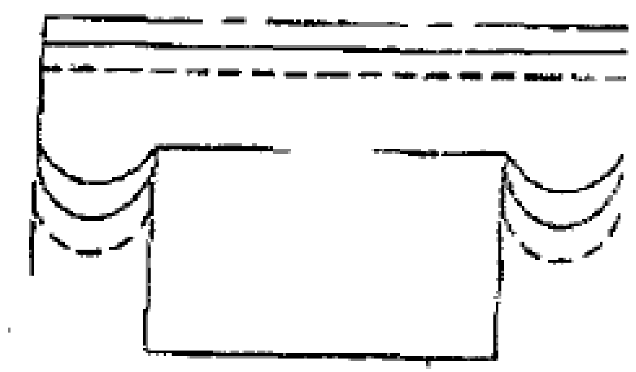


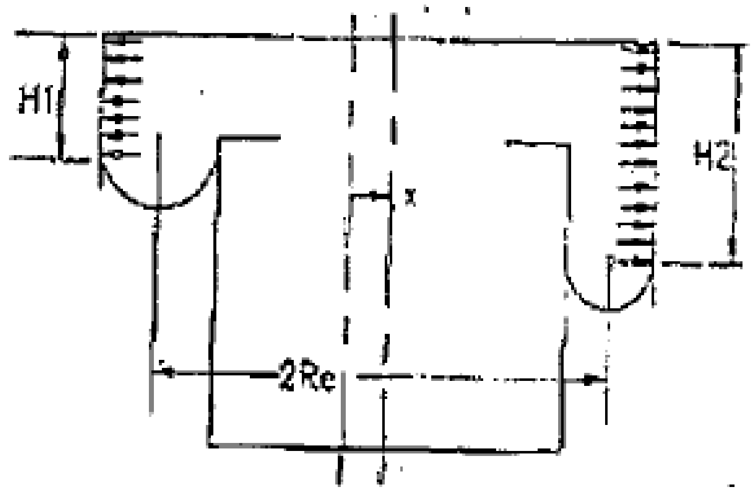
Fig. Working principle of Air spring

AIR SPRINGS – WORKING PRINCIPLE

The Fundamental Principle (Contd…)



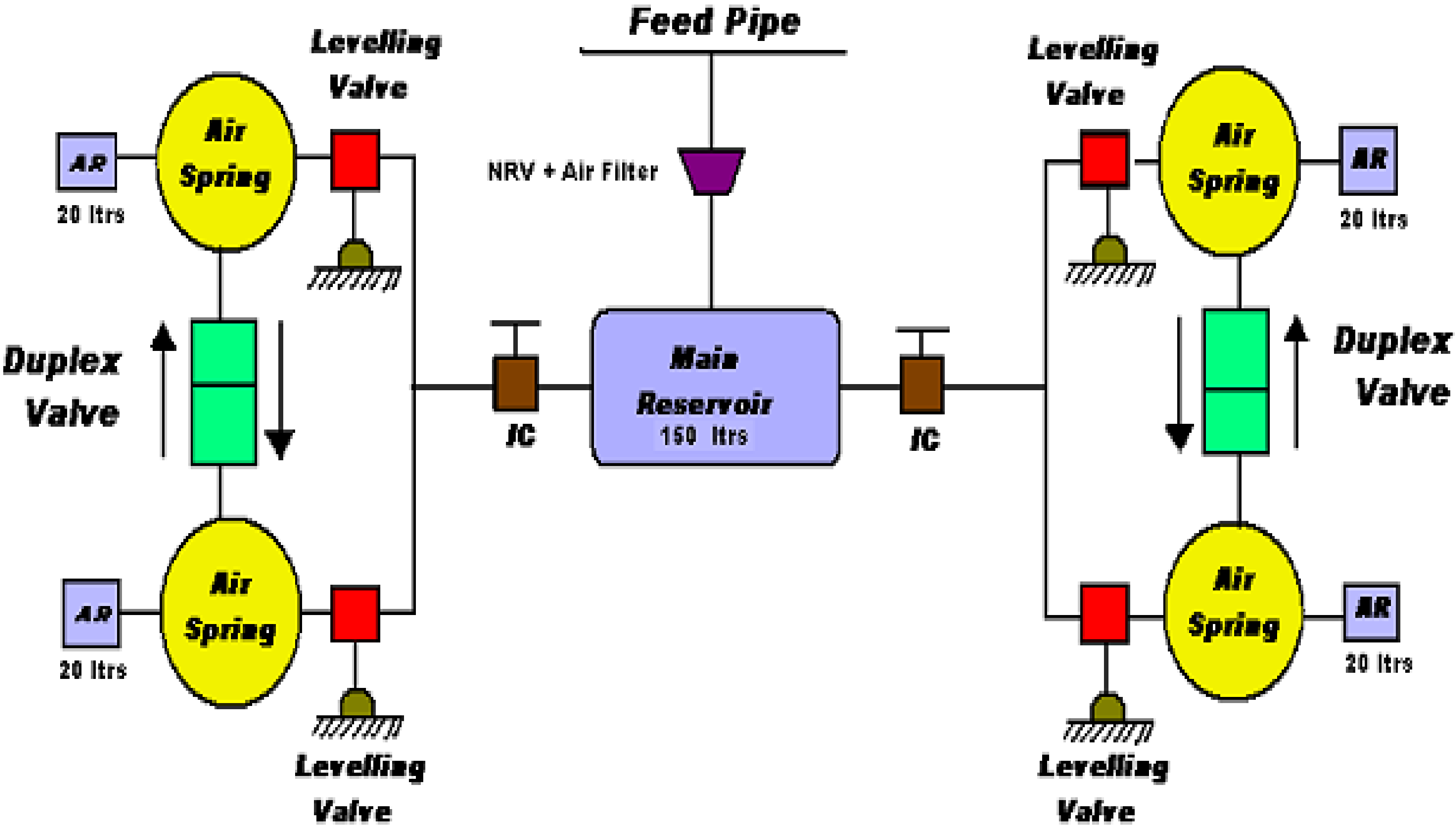
Vertical Spring Action



Lateral Spring Action

FIG. No.3 VERTICAL AND LATERAL ACTION OF AIR SPRING

AIR SPRING SYSTEM – DIAGRAM

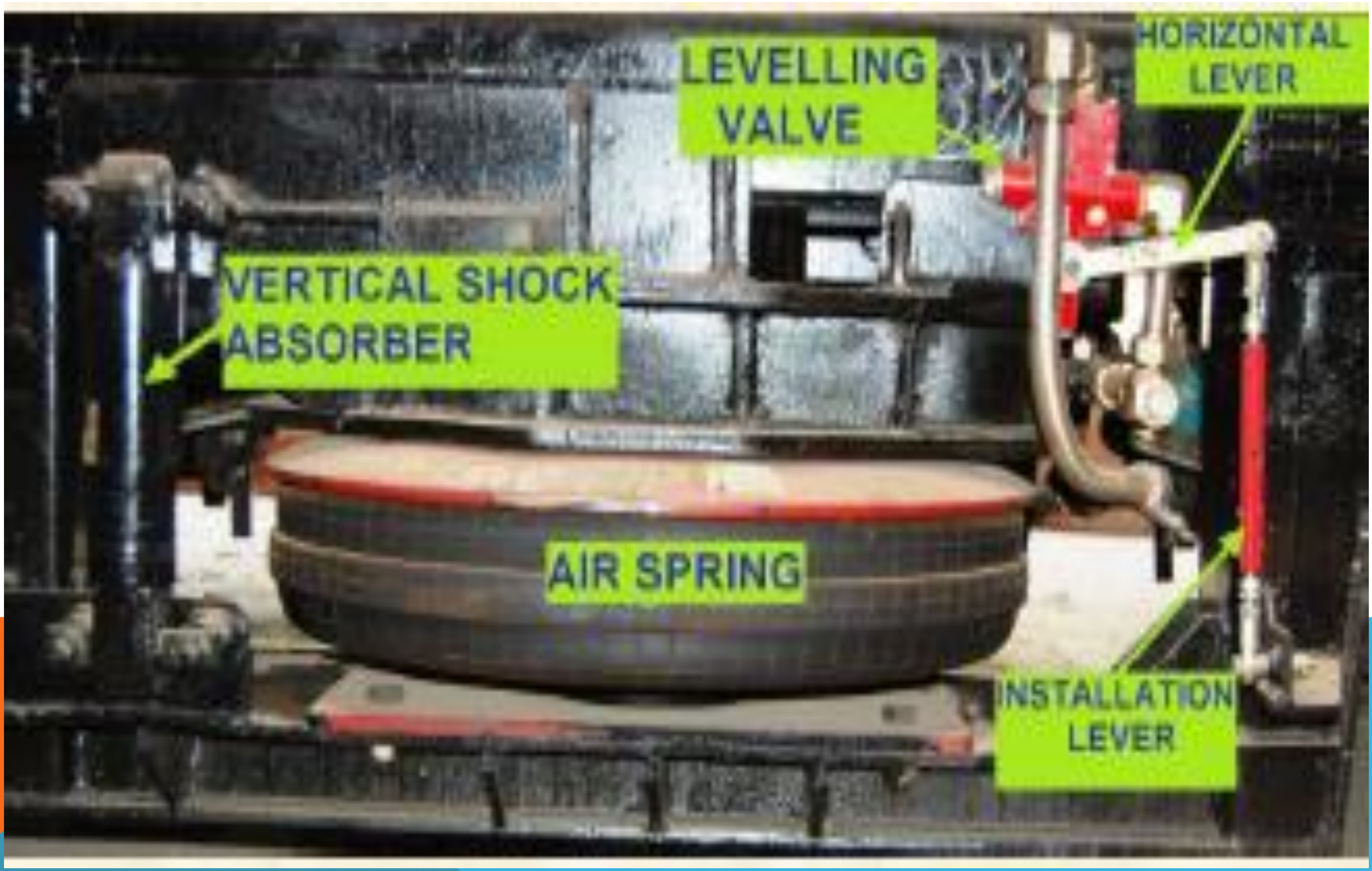


AIR SPRING SYSTEM – COMPONENTS

Main equipments of Air suspension system:

1. Air spring - 04 Nos /Coach
2. Levelling valve - 04 Nos /Coach
3. Duplex check valve - 02 Nos /Coach
4. 40 ltrs auxiliary reservoir - 04 Nos /Coach
5. Bogie suspension isolating cock - 02 Nos /Coach
6. Non return valve - 01 No /Coach
7. 150 ltrs MR reservoir - 01 No /Coach
8. Coach suspension isolating cock - 01 No /Coach

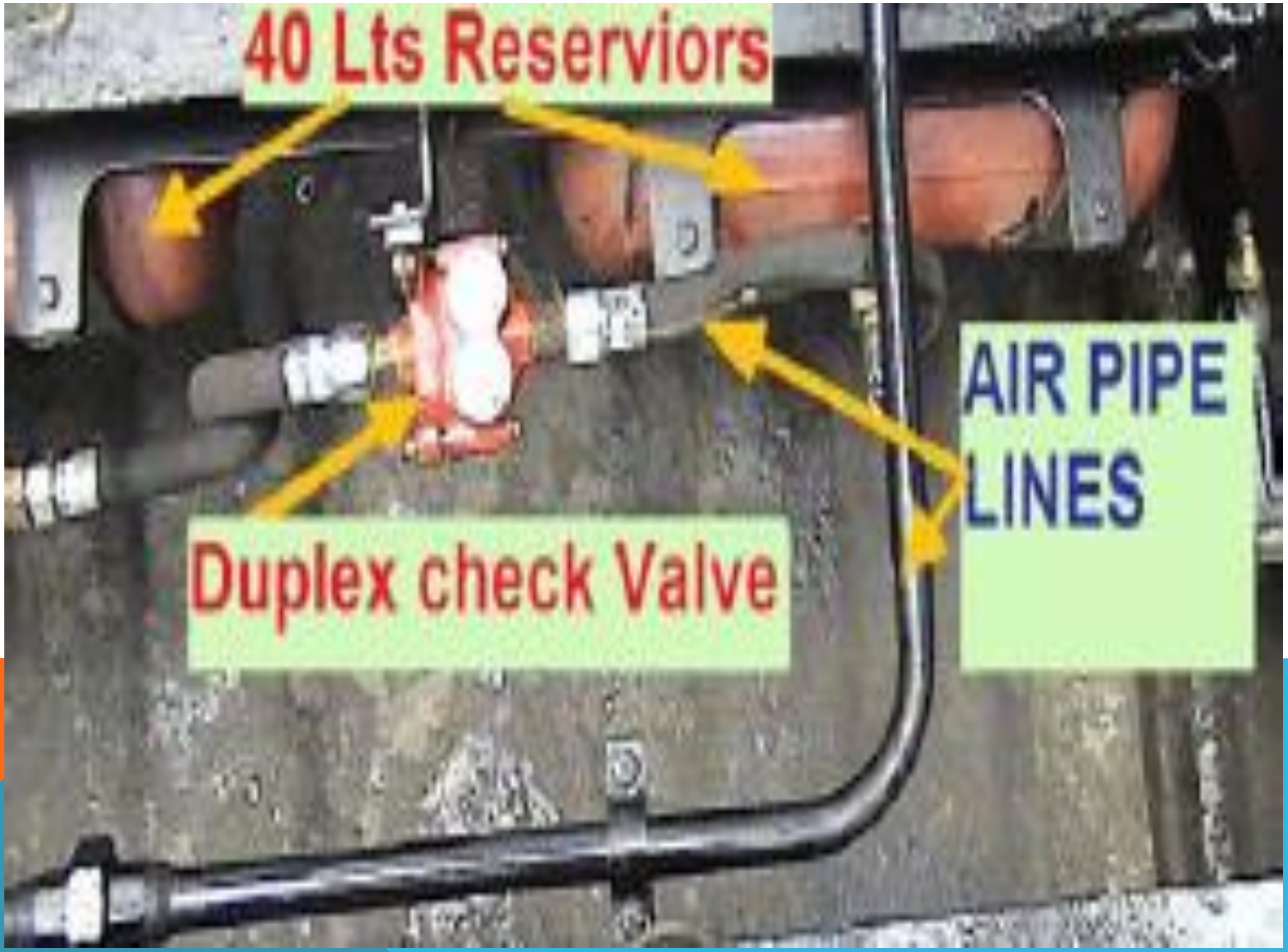
AIR SPRINGS SYSTEM – PARTS



AIR SPRINGS – RUBBER BELLOW

AIR SPRINGS – RESERVOIR

AIR SPRINGS – DUPLEX CHECK VALVE



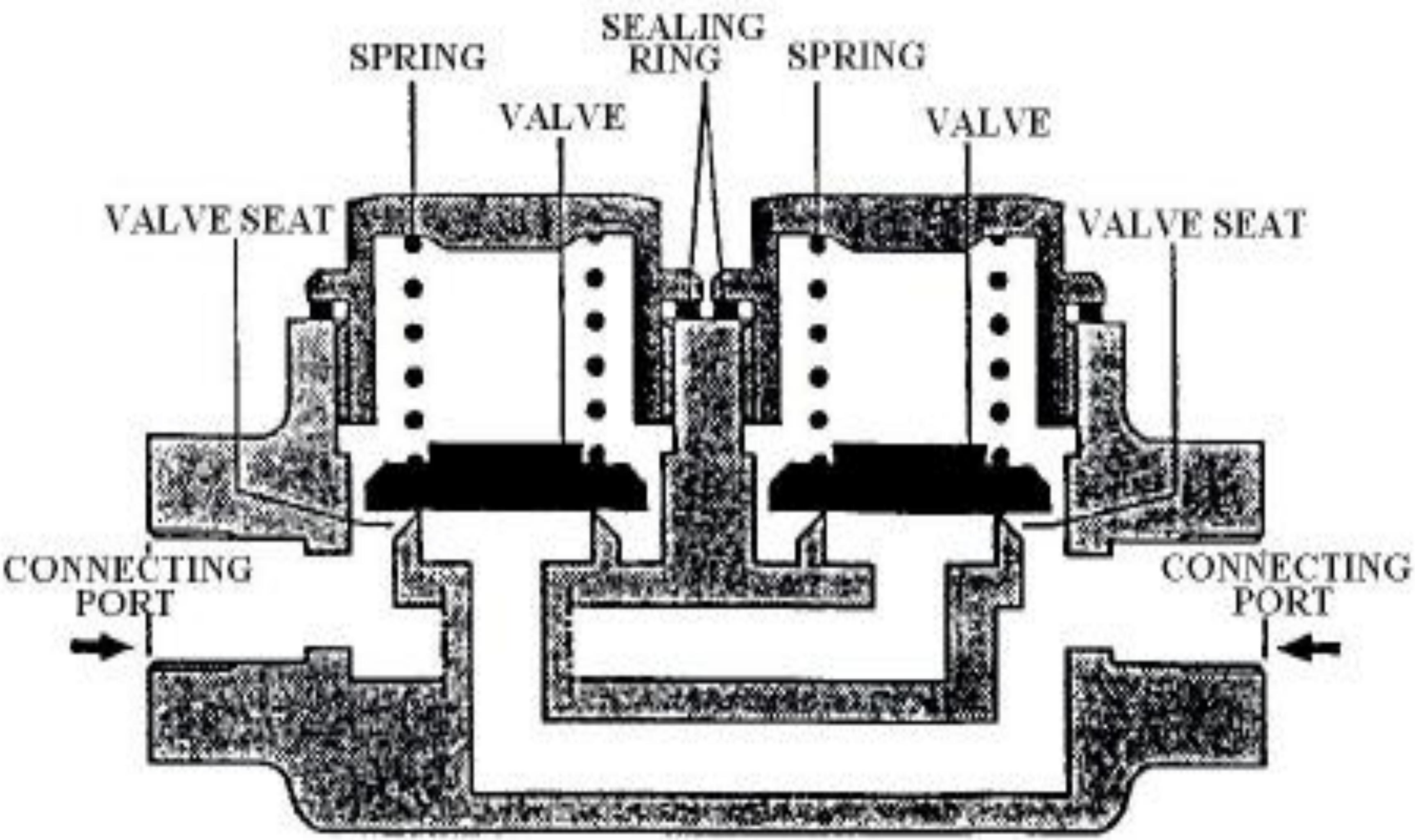
AIR SPRINGS – DUPLEX CHECK VALVE

Combination of Two Check Valves
in Opposite Direction

Installed between Air Springs of Same Bogie

To Prevent Severe Tilt if
Differential Pressure of
Adjacent Bellows > 1.5 Bar

AIR SPRINGS – DUPLEX CHECK VALVE



AIR SPRINGS – INSTALLATION LEVER HORIZONTAL LEVER

Installed between Cradle and Leveling Valve
Installation Lever – Setting of Length
Horizontal Lever – Feedback to Leveling Valve
Lever Length–305 mm   Spring Height–255 mm

AIR SPRINGS – LEVELING VALVE

Installed on Bogie Bolster

Acts on Feedback from Position of Horizontal Lever

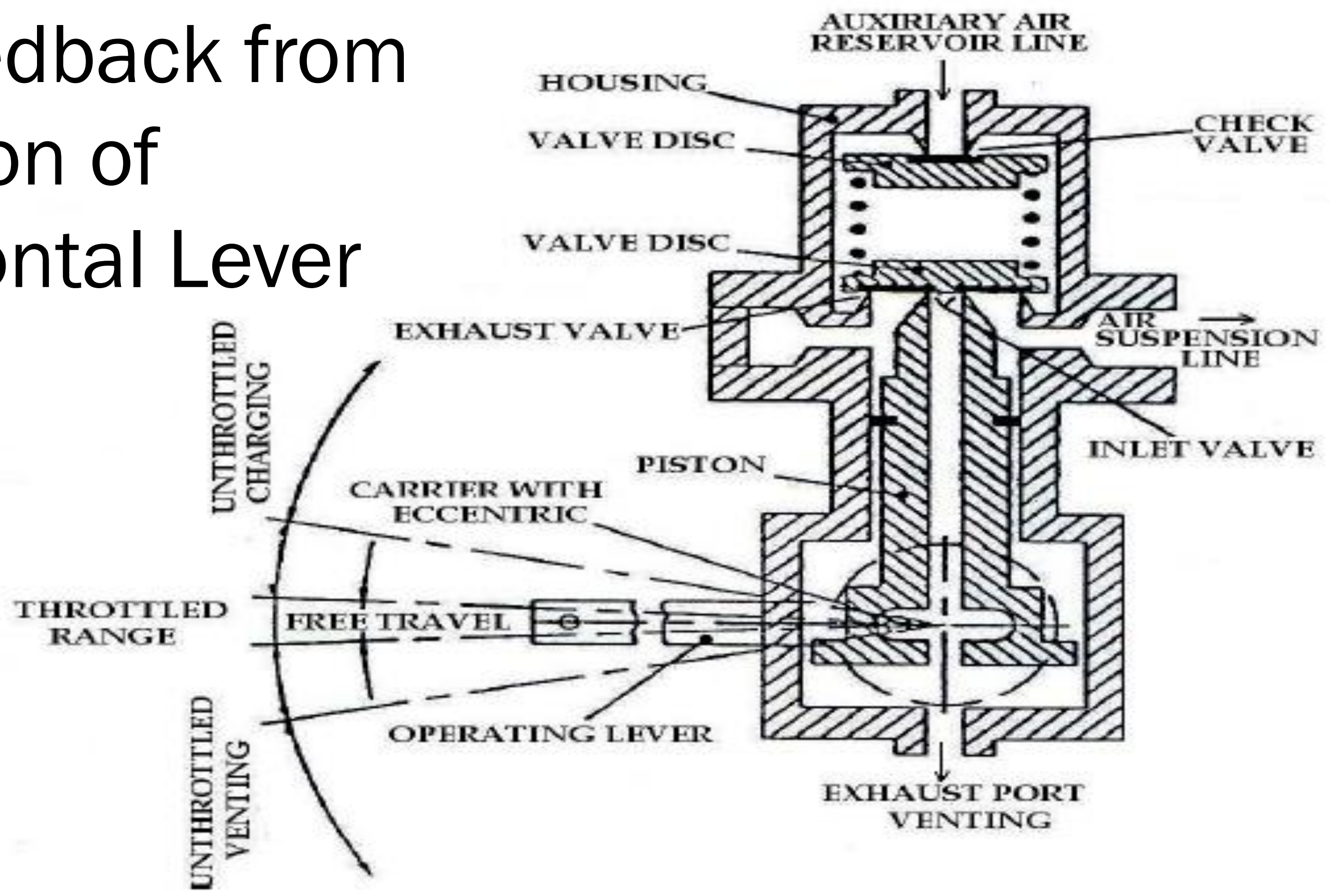


FIG. THROTTLED AIR SUSPENSION LEVELLING VALVE (Lap Position)

AIR SPRINGS – LEVELING VALVE

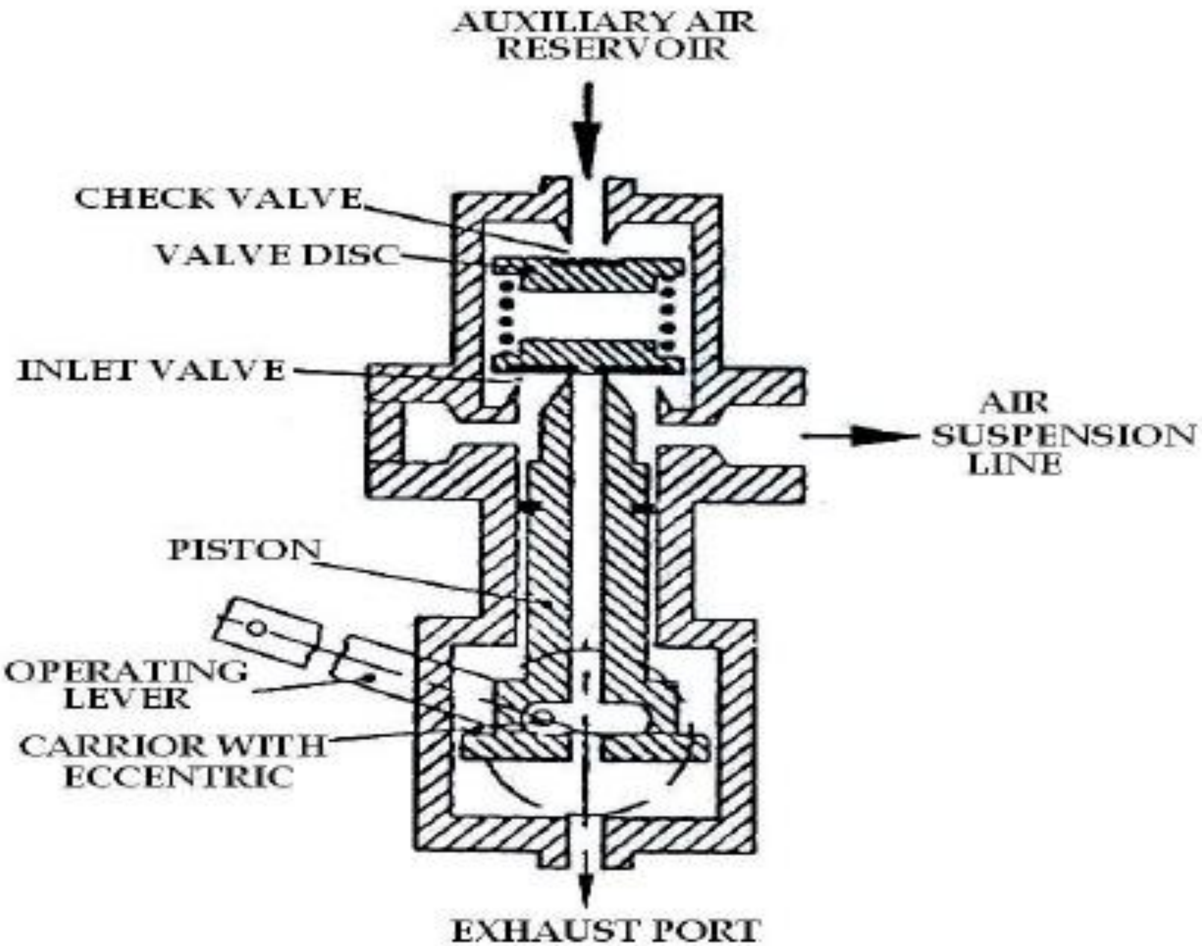


FIG. CHARGINGN OF THE AIR SUSPENTION BELLOWS

AIR SPRINGS – LEVELING VALVE

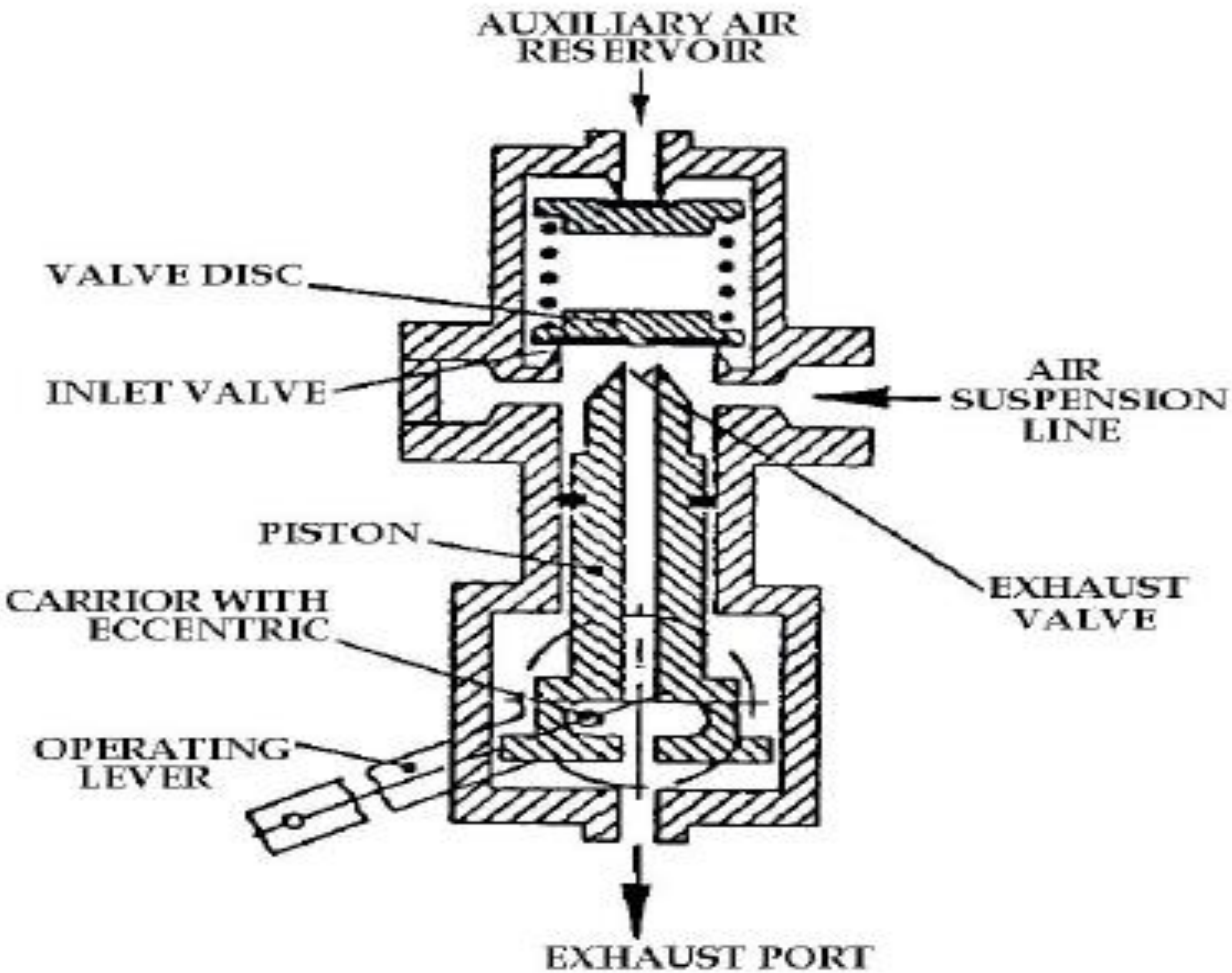
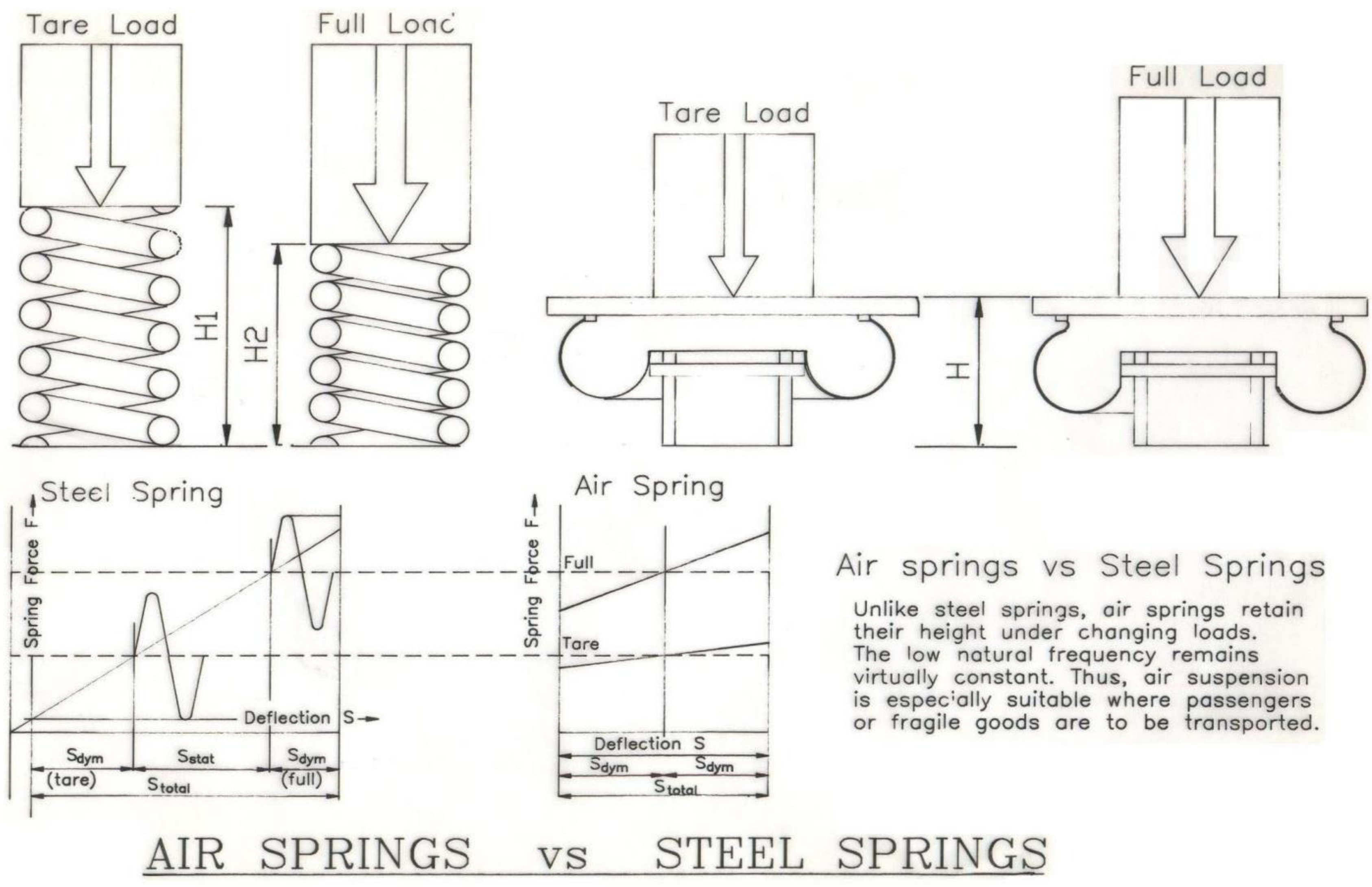


FIG. VANTING OF THE AIR SUSPENTION BELLOWS

AIR SPRING VS STEEL SPRINGS



IN SECONDARY SUSPENSION

Benefits of Air Springs

- Load Proportionate Stiffness –
- Maintains Constant Height at Varying Loads
- Reduction in No. of Variants
- Less Failures as compared to Helical Springs
- Superior Ride Quality
- Improvement in Ride Index(RI)

IN SECONDARY SUSPENSION

Disadvantages of Air Spring

- Higher Initial Cost
- Additional Air Pipeline required
- Air Pressure must be maintained
- Special Care to be taken in Maintenance to avoid Oil and Paint Spillage on Rubber Bellow

MAINTENANCE

- Leakage Test of Air Spring
  - At 6/9 kg/cm^2 (*CAMTECH*/RDSO 2008)
  - Drop in Pressure within *0.2/0.1*/1% in 1 hour
- Installation Lever Adjustment
  - Height of Air Spring
  - Pressure in Air Spring
- Pressure Difference between Air Springs
  - For same Height
    - Should not be more than 1.5 bar

FAILURE INDICATION & BRAKE APPLICATION (FIBA)

In Case of Failure of Air Spring

Failure of Supply of Air

Rupture of Air Spring Bellow

Warrants reduction in Speed

In order to communicate the Crew

To acknowledge Failure of Air Spring

and to move at reduced speed

FIBA is installed

FAILURE INDICATION & BRAKE APPLICATION (FIBA)

Features of FIBA

- 02 Set per Coach – 01 set per Bogie
- Each set consists 02 valve per bogie
  - To sense Pressure of each Air Spring
- Pressure of Any Spring goes < 1.0 kg/cm^2
  - FIBA actuates
  - Connects BP to Atmosphere
  - Application of Full Service Brake

FAILURE INDICATION & BRAKE APPLICATION (FIBA)

Features of FIBA (Contd…)

- Hissing Steady Sound of 90 + 5 dB
  - To attract attention of Crew
- 04 Indicators per coach
  - Change color Green to Red
    - Till Rectification of Bellow
    - Resetting of FIBA
      - Closing Isolating Cock
      - Manual Key

FAILURE INDICATION & BRAKE APPLICATION (FIBA)

FIBA is to be fitted in All 1600 HP DEMU

- Fitted with Air Suspension (Letter 13-04-17)
- New Coaches by ICF
- Old Coaches in Zonal Railway
  - Supply Order by ICF

RELEVANT TECHNICAL INSTRUCTIONS

RDSO Maintenance Manual No. CMI-9802 Rev.2

RDSO Technical Instruction No. CMI-K401

CAMTECH Publication

CAMTECH/M/C/2010-11/Air Sus. System/1.0

For Air Suspension System

Maintenance Manual for 1400 HP DEMU