DIESEL LOCOMOTIVE

TRACTION SCENARIO

The evolution of traction scenario in the World Railways has been as under:-

- STEAM TRACTION : The first steam locomotive in the World was introduced in the year 1801.

- ELECTRIC TRACTION : The year 1881 saw the birth of the first electric railway run by W.V.Siemens, a German Engineer using both the rails to carry the current. Finding this a little too dangerous, Siemens soon adopted the overhead electric wires.

- DIESEL TRACTION : The Diesel engine was invented by a German Engineer, called Rudolf Diesel in the year 1893 and the first Diesel locomotive came into existence in the year 1912.

  From the above, it would be seen that Diesel traction is more modern as compared to Electric traction. Moreover, due to cost effectiveness of Diesel traction, modern economic powers like USA, Canada and Australia have opted for Diesel traction.

INTRODUCTION OF DIFFERENT TYPES OF TRACTION IN I.R

◆In the first one hundred years, Indian Railways depended basically on steam and small scale electrification in Bombay(Mumbai) and Madras(Chennai) suburbans.

◆The electric traction was first introduced on Indian Railways in 1925 with 1500 volts DC (Victoria Terminus to Kurla)

- First mainline Diesel Locomotive was introduced in Metre Gauge in 1954 by Western Railway.
  In 1957, 100 nos. of WDM1 Locomotives (B.G.) were procured from American Locomotive Company, followed by WDM2 Locomotives.

Classification of Locomotives

- In India, locomotives are classified according to their track gauge, motive power, the work they are suited for and their power or model number. The class name includes this information about the locomotive. It comprises 4 or 5 letters.
- The first letter denotes the track gauge.
- The second letter denotes their motive power (Diesel or Electric) and
- The third letter denotes the kind of traffic for which they are suited (goods, passenger, mixed or shunting).

- The fourth letter used to denote locomotives' chronological model number. However, from 2002 a new classification scheme has been adopted. Under this system, for **newer diesel** locomotives, the fourth letter will denote their horsepower range. Electric locomotives don't come under this scheme and even all diesel locos are not covered. For them this letter denotes their model number as usual.

- A locomotive may sometimes have a fifth letter in its name which generally denotes a technical variant or subclass or subtype. This fifth letter indicates some smaller variation in the basic model or series, perhaps different motors, or a different manufacturer. With the new scheme for classifying diesel locomotives (as mentioned above) the fifth item is a letter that further refines the horsepower indication in 100 hp increments: 'A' for 100 hp, 'B' for 200 hp, 'C' for 300 hp, etc. So in this scheme, a WDM-3A refers to a 3100 hp loco, while a WDM-3F would be a 3600 hp loco.

The classification syntaxes

The first letter (gauge)

- W-Indian broad gauge (The "W" Stands for Wide Gauge - 5 Feet)
- Y-metre gauge (The "Y" stands for Yard Gauge - 3 Feet)
- Z-narrow gauge(2 ft 6 in)
- N-narrow gauge (2 ft)

The second letter (motive power)

- D-Diesel
- C-DC electric (can run under DC traction only)
- A-AC electric (can run under AC traction only)
- CA-Both DC and AC (can run under both AC and DC tractions), 'CA' is considered a single letter
- B-Battery electric locomotive (rare)

The third letter (job type)

- G-goods
- P-passenger
- M-mixed; both goods and passenger
- S-Used for shunting (Also known as switching engines or switchers in United states and some other countries)
- U-Electric multiple units (used as commuters in city suburbs)
- R-Railcars

For example, in "**WDM 3A**":

- "W" means broad gauge
- "D" means diesel motive power
- "M" means suitable for mixed(for both goods and passenger)service
- "3A" means the locomotive's power is 3,100 hp ('3' stands for 3000 hp, 'A' denotes 100 hp more)

Or, in "**WAP 5**":

- "W" means broad gauge
- "A" mean AC electric traction motive power
- "P" means suitable for Passenger service
- "5" denotes that this locomotive is **chronologically** the fifth electric locomotive model used by the railways for passenger service.
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- **FEATURES OF VARITIES OF LOCO WORKING IN INDIAN RAILWAY**

SR. NO.	LOCOTYPE	WHEEL ARRAN--GEMENT	WEIGT	GEAR RATIO	MAX. SPEED MPH	WHEEL DIAMETER (M.M.)	HORSE POWER	DIESEL ENGINE	BRAKE	LOCO	TRAIN
1	YDM4	Co-Co	72 T.	19:92	96	965	1350	251-D 6CYL. IN LINE.	28 LV-1	AIR& DYNA.	VACU.
2	WDM2	Co-Co	112.8 T	18:65	120	1092	2600	251-B 16CYL.	28 LAV-1	AIR	AIR& VAC.
3	WDS6	Co-Co	126 T	18:74	60	1092	1350/ 1200	251-D, 6 CYL.	28 LAV-1	AIR	AIR& VAC.
4	WDG2	Co-Co	123 T	18:74	100	1092	3100	DLW 251-B,16 CYL. UPRATED	IRAB-I, PANEL MOUNTED	AIR & DYNA.	AIR
5	WDP1	Bo-Bo	80 T	18:65	120	1092	2300	251-B, 12CYL .UPRATED	28 LAV-1	AIR	AIR& VAC.
6	WDP2	Co-Co	117 T	22:61	160	1092	3100	DLW 251-B, 16 CYL. UPRATED	IRAB-I,PANEL MOUNTED	AIR& DYNA.	AIR
7	WDM2C	Co-Co	112.8 T	18:65	120	1092	3100	DLW 251-B, 16 CYL. UPRATED	IRAB-I, PANEL MOUNTED	AIR& DYNA.	AIR
8	WDP3A	Co-Co	117 T		160	1092	3100	251-B 16 CYL.UPRD	IRAB-1 PANEL MOUNTED	AIR	AIR
9	WDG3A	Co-Co	123 T	18:74	100	1092	3100	251-B 16 CYL.UPRD	IRAB-1	AIR	AIR
10	WDG4	Co-Co	126 T	17:90	100	1092	4000	16-710 G3B	ELECTRONIC AIR BRAKE	AIR & DYNA.	AIR
11	WDP4	AA-1	117 T	17:77	160	1092	4000	16-710 G3B	43" DIA ELECTRONIC AIR BRAKE	AIR & DYNA.	AIR

TYPES OF LOCO NORMALLY USED FOR CARRYING FREIGHT & PASSENGER TRAIN

1. YDM4 :- This is powered by 251-D type 6-cylinder, 4-stroke ALCO/DLW/MLW diesel engine developing 1400 HP at 1100 r.p.m. under standard condition, Provided with DC-DC transmission. Used in goods as well as passenger carrying train.

2. WDM2 :-This type of loco is powered by one ALCO/DLW make 251-B type 16-cylinder , 4-stroke developing 2636 HP under standard condition. Provided with DC-DC transmission, Used in goods as well as passenger carrying train.

3. WDS6 :- These locomotives are designed for handling long and heavy train loads in steel plants and industrial yards . They are powered by a single 251-D type 6 cylinder diesel engine developing 1400 HP at 1100 rpm under standard conditions

4. WDM2C/ WDM3A :- This type of locomotive is provided with DLW make 251 B uprated fuel efficient 16 cylinder diesel engine capable of producing3100 HP at 1050 r.p.m. Provided with AC- DC transmission. Used in goods as well as passenger carrying train.

5. WDG2/ WDG3 :- This type of loco is provided with DLW 251 B uprated fuel efficient 16 cylinder diesel engine capable of producing 3100 HP at 1050 r.p.m. under standard condition Provided with AC- DC transmission ,Used in goods train.

6. WDG4:- This type of loco is provided with engine make EMD 710 G3B, 16 cylinder two stroke diesel engine ,capable of developing 4000 HP with maximum speed of 100 KMPH., Equipped with AC-AC transmission , Used in goods train.

7. WDP4:- This type of loco is provided with engine make EMD 710 G3B, 16 cylinder two stroke diesel engine, capable of developing 4000 HP with maximum speed of 160 KMPH., Equipped with AC-AC transmission , Used in passenger carrying train.

MAIN COMPARTMENTS OF DIESEL LOCOMOTIVE

–NOSE COMPARTMENT
–CAB COMPATRMENT
–GENERATOR COMPARTMENT
–ENGINE COMPARTMENT
–EXPRESSOR / COMPRESSOR COMPARTMENT
–RADIATOR COMPARTMENT

WDM2 LOCOMOTIVE

FUEL OIL SYSTEM

The fuel oil system is designed to introduce fuel oil into the engine cylinders at the correct time, at correct high pressure, at correct quantity and correctly atomised. The system injects into the cylinder correctly metered amount of fuel in highly atomised form at a stipulated time in the four stroke cycle operation of the engine. High pressure of fuel is required for lifting the nozzle valve and penetration of fuel into the pressurised combustion chamber. High pressure also helps in proper atomization so that the small droplets come in better contact with the fresh air in combustion chamber and thus have better combustion. Metering the fuel to correct required quantity is important because the locomotive engine is a variable speed and variable load engine with variable requirement of fuel within a particular range.Timing the injection of fuel is also important to enable fuel to burn completely for maximum benefit out of it.

The fuel oil system is the combination of two system:-

(i) Fuel feed system
(ii) Fuel injection system.

FUEL FEED SYSTEM:-

The fuel feed system includes the following: -

(1) Fuel oil tank
(2) Fuel primary filter
(3) Fuel transfer pump / fuel booster pump
(4) Fuel relief valve
(5) Secondary filter
(6) Fuel regulating valve
(7) Fuel oil header

The fuel feed system provides the backing up support to the fuel injection pumps by maintaining steady supply of fuel for them at a pressure of 3.00 Kg/cm sq.- 3.5 Kg/cm sq. so that the fuel pumps in turn can meter and deliver the oil to the cylinders at correct pressure and time.

FUEL INJECTION SYSTEM:-

The fuel injection system includes the following:-

(1) Fuel Injection Pump

(2) Fuel Injection Nozzle
(3) High Pressure Tube

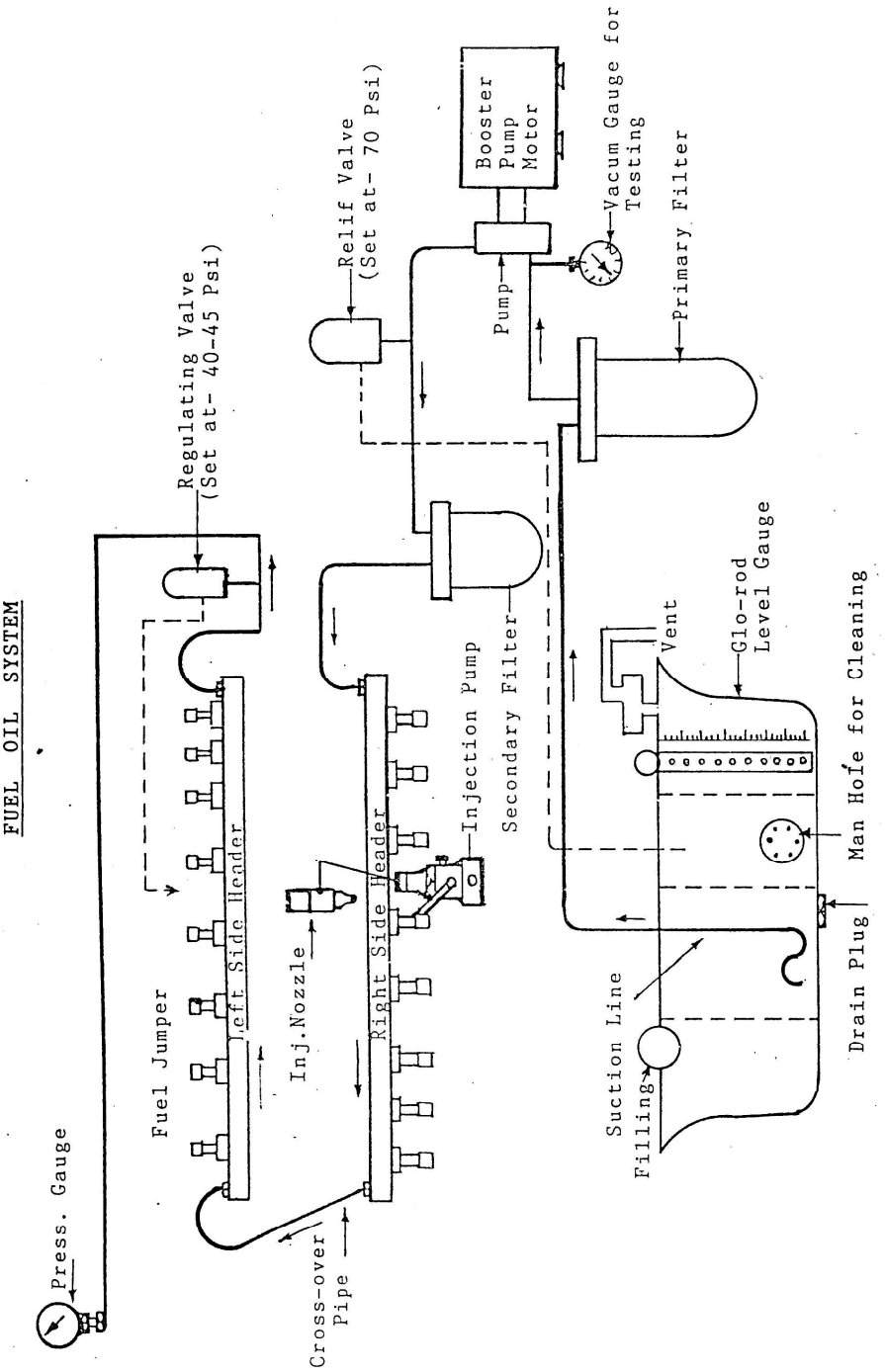


FIG. FOS-1

LUBE OIL SYSTEM

The lubricating system in a diesel engine is of vital importance. The lubricating oil besides providing a film of soft slippery oil in between two frictional surfaces to reduce friction and wear, also serves the following purposes: -

1. Cooling of bearings, pistons etc.
2. Protection of metal surfaces from corrosion, rust, surface damage and wear.
3. Keep the components clean and free from carbon, lacquer deposits and prevent damage due to deposits.

- The importance of lube oil system is comparable with the blood circulation system in the human body. Safety of the engine, it's components and their life span will largely depend on correct quality of oil at correct quantity and pressure to various locations of the diesel engine.

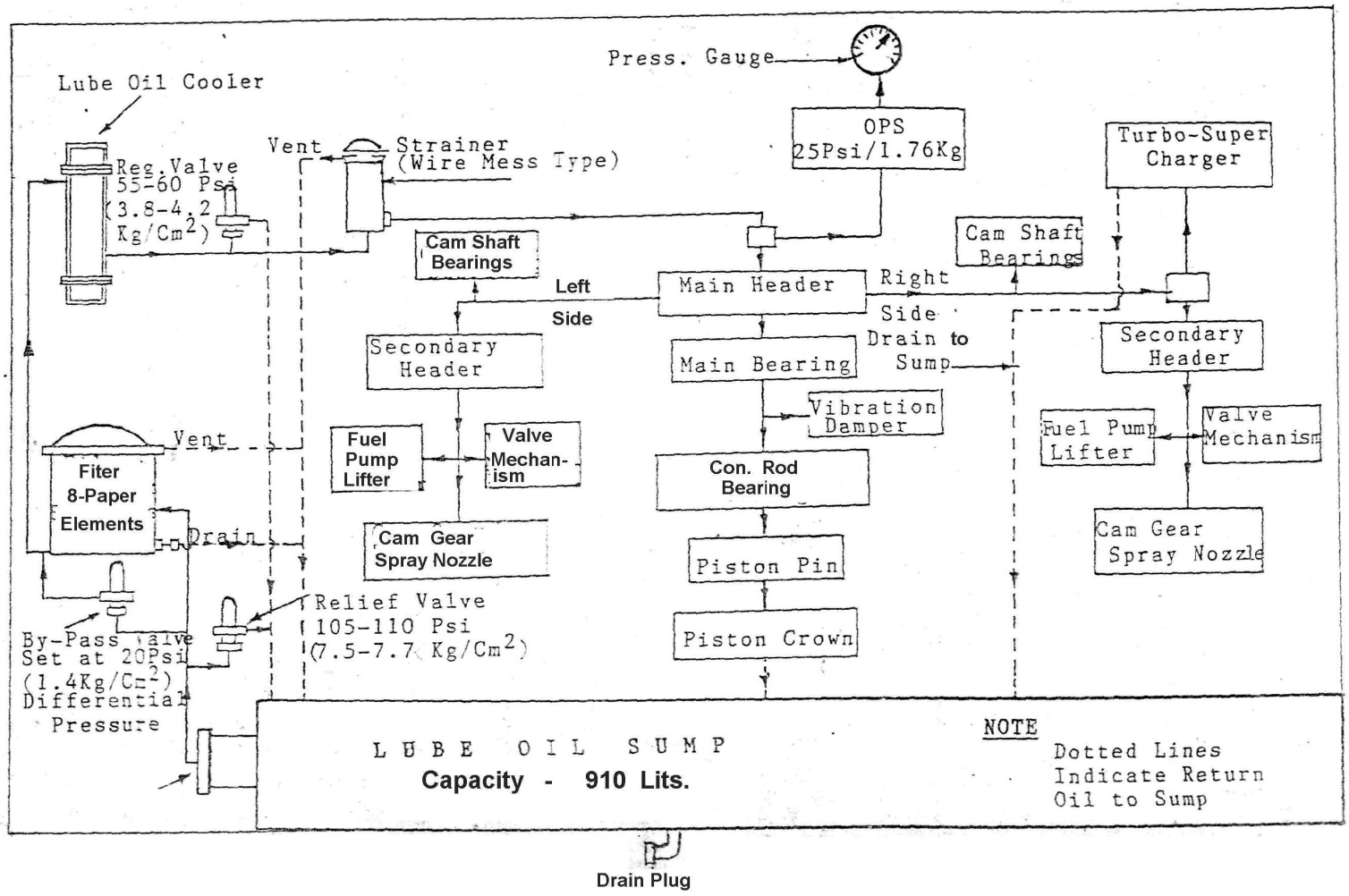
- LUBE OIL PUMP:- It is the most vital item of the lube oil system , which is used to pump lube oil in the system. It is mounted on the free end of the base and is driven by diesel engine crankshaft extension gear. The oil suction line from the sump is built into the base & lines up with the inlet passage cast into the pump housing, the pump discharges into the external piping through flange on the pump body.

The Lube oil system consists of the following components mainly;

(1) Lube oil sump
(2) Lube oil pump
(2) Relief Valve
(3) By pass valve
(4) Lube oil filter
(5) Lube oil cooler
(6) Regulating valve
(7) Strainer
(8) Main header
(9) Secondary header (Left)
(10) Secondary header (Right)
(11) OPS
(12) Lube oil pressure gauge

LUBRICATING OIL SYSTEM

FIG. LOS-1



COOLING WATER SYSTEM

After combustion of fuel in the engine about 25% to 30% 0f heat produced inside the cylinder is absorbed by the components surrounding the combustion chamber i.e. Piston, Cylinder, Cylinder head etc. Unless the heat is taken away from them and dispersed elsewhere, the components are likely to fail under thermal stresses. All internal combustion engines are provided with a cooling system designed to cool the excessively hot components, distribute the heat to other surrounding components to maintain uniform temperature through out the engine and finally dissipate the excess heat to atmosphere to keep the engine temperature within suitable limit. Different cooling systems like air cooling and water cooling are adopted depending on the engine design, working conditions and service etc. The advantage of having water cooling is that it maintains uniform level of temperature throughout the engine and by the control on water temperature the engine temperature is also effectively controlled.

A centrifugal pump driven by the engine crank shaft through a gear, suck water from the system and deliver through the outlet under pressure. The outlet of the pump has three branch lines from a three way elbow. The branching off leads water to the different places as follows: -

WATER CIRCULATING PUMP :- Water pump is the main part of cooling system. It is used to circulate the cooling water in the system. This is located on the free end of the engine and is driven by the crank-shaft extension gear. The pump bearing housing is connected through a flange connection ; suction & discharge piping are connected directly to the suction and discharge flange of the pump.

WATER COOLING SYSTEM

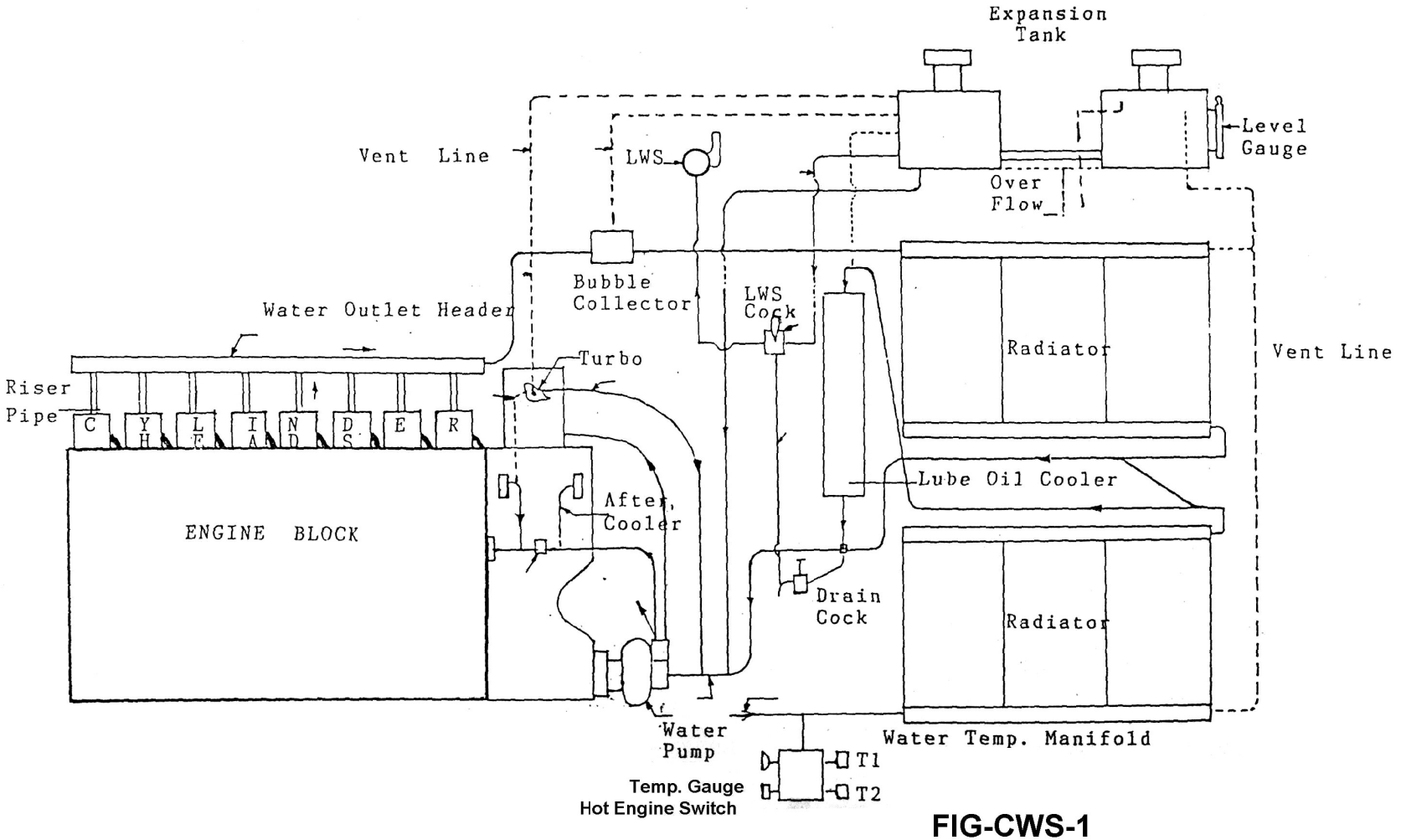


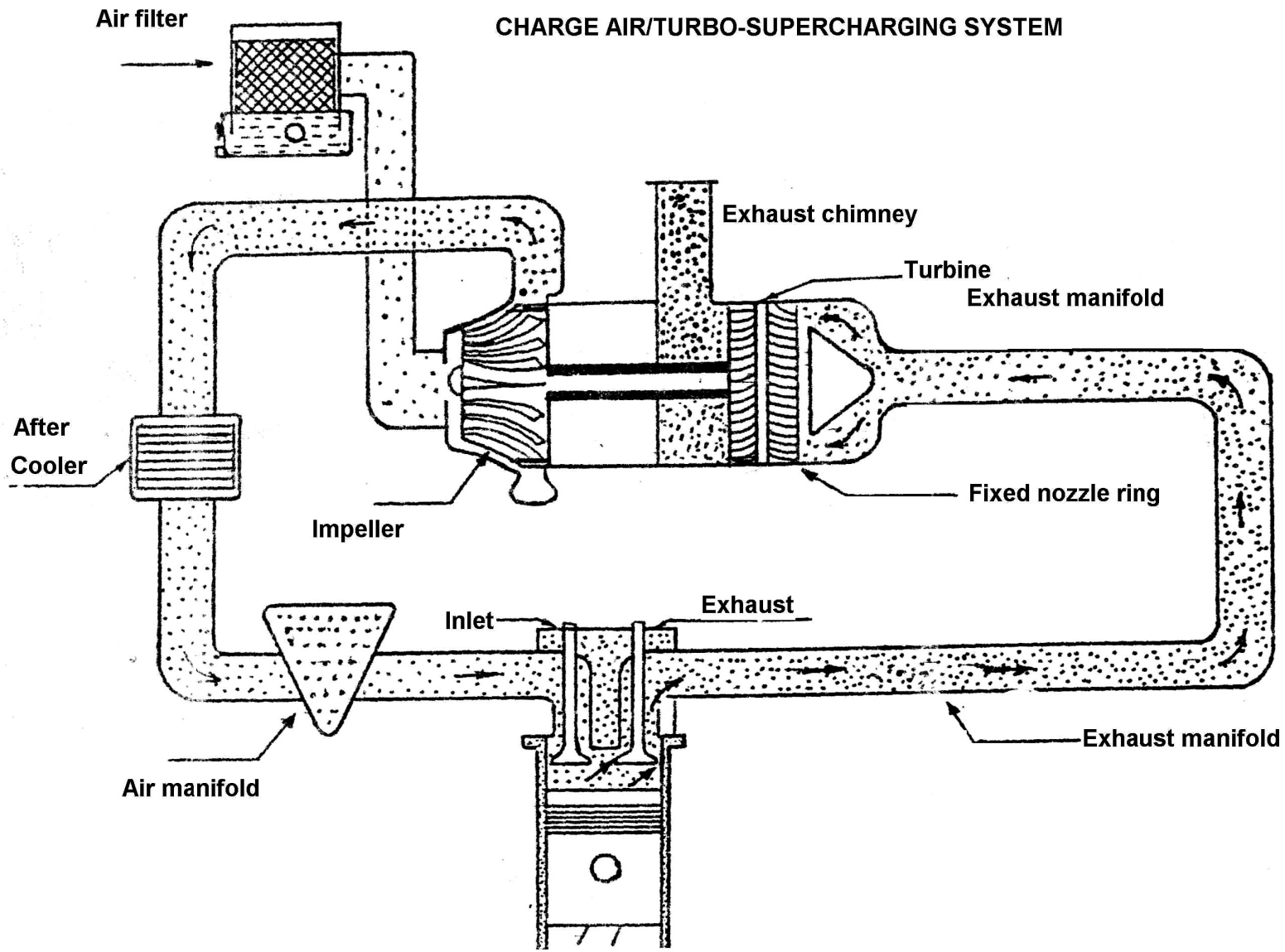
FIG-CWS-1

CHARGE AIR SYSTEM

- The diesel engine produces mechanical energy by converting heat energy derived from burning of fuel inside the cylinders. For efficient burning of fuel availability of sufficient air in proper ratio is a pre-requisite.

  In a naturally aspirated engine, during the suction stroke, air is being sucked into the cylinder from atmosphere due to displacement of the pistons. The volume of air thus drawn into the cylinder through restricted inlet valve passage within a limited time, would also be limited and at a pressure slightly less than the outside atmosphere. The availability of less quantity of air of low density inside the cylinder, would limit the scope of burning only a matching quantity of fuel. Hence mechanical power produced in the cylinder also is limited.

  An improvement on the naturally aspirated engines are the supercharged or pressure charged engines. During the suction stroke pressurised air of higher density is being charged into the cylinder through the open suction valve. Air of higher density containing more oxygen will make it possible to inject more fuel into the same size of cylinder and produce more power by effectively burning it.


Air filter
CHARGE AIR/TURBO-SUPERCHARGING SYSTEM
Exhaust chimney
Turbine
Exhaust manifold
After
Cooler
Impeller
Fixed nozzle ring
Inlet
Exhaust
Air manifold
Exhaust manifold

EXPRESSOR

(6 CD, 4 UC COMPRESSOR EXHAUSTER)

In Indian Railways, the trains normally work on vacuum brakes and the diesel locos on air brakes. As such provision has been made on every diesel loco for both vacuum and compressed air for operation of the system as a combination brake system for simultaneous application on locomotive and train.

In ALCO locos the exhauster and the compressor are combined into one unit and it is known as EXPRESSOR. It creates 22" of vacuum in the train pipe and 140 PSI air pressure in the reservoir for operating the brake system and use in the control system etc.

- The expressor is located at the free end of the engine block and driven through the extension shaft attached to the engine crank shaft. The two are coupled together by splined flexible coupling (Kopper's coupling). Naturally the expressor crank shaft has eight speeds like the engine crank shaft and runs between 400 RPM to 1000 RPM range.

CONSTRUCTION AND DESCRIPTION:-

The expressor consists of the following components mainly;

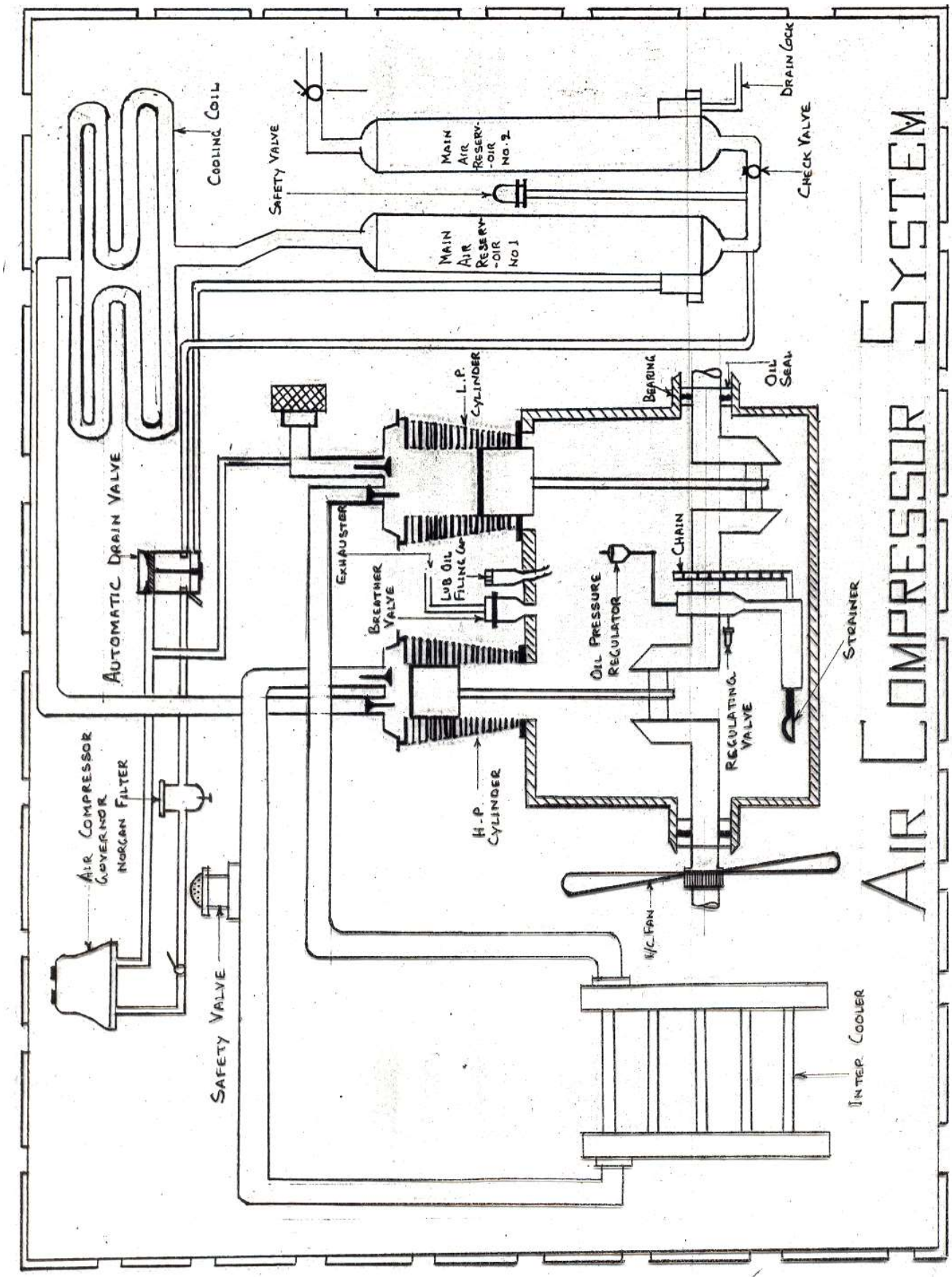
- (1) Crank case (2) Crank shaft (3) Four Nos. of exhauster cylinders with cylinder heads (4) One low pressure compressor cylinder with cylinder head (5) One high pressure cylinder with cylinder head (6) Six nos. of pistons with connecting rods (including one LP, one HP and four exhauster). (7) Lube oil pump.

- Each of two crank journals support three connecting rods The crank shaft is supported at the both ends by double row ball bearings. Outside the ball bearings are located oil seals to prevent the leakage of oil from inside the crank case and air from out side into it.

COMPRESSOR

The compressor is a two stage compressor with one low pressure cylinder and one high pressure cylinder. During the first stage of compression it is done in the low pressure cylinder where suction is through a wire mesh filter. After compression in the LP cylinder air is delivered into the discharge manifold at a pressure of 30 / 35 PSI. Working of the inlet and exhaust valves are similar to that of exhauster which automatically open or close under differential air pressure. For inter-cooling air is then passed through a radiator known as inter-cooler. This is an air to air cooler where compressed air passes through the element tubes and cool atmospheric air is blown on the out side fins by a fan fitted on the expressor crank shaft. Cooling of air at this stage increases the volumetric efficiency of air before it enters the high pressure cylinder. A safety valve known as inter cooler safety valve set at 60 PSI is provided after the inter cooler as a protection against high pressure developing in the after cooler due to defect of valves.

After the first stage of compression and after-cooling the air is again compressed in a cylinder of smaller diameter to increase the pressure to 135-140 PSI in the same way. This is the second stage of compression in the HP cylinder. Air again needs cooling before it is finally sent to the air reservoir and this is done while the air passes through a set of coiled tubes below the loco superstructure.


AIR COMPRESSOR SYSTEM
COOLING COIL
SAFETY VALVE
MAIN AIR RESERV-OIR NO. 2
MAIN AIR RESERV-OIR NO 1
DRAIN COCK
CHECK VALVE
AUTOMATIC DRAIN VALVE
L.P. CYLINDER
BEARING
OIL SEAL
EXHAUSTER
BREATHER VALVE
LUB OIL FILLING CAP
CHAIN
OIL PRESSURE REGULATOR
STRAINER
REGULATING VALVE
H.P. CYLINDER
AIR COMPRESSOR GOVERNOR
NORGAN FILTER
SAFETY VALVE
F/C FAN
INTER. COOLER

OVER VIEW OF DIESEL LOCOMOTIVE BRAKE SYSTEM

Type of brake system -	Designed by –	Fitted on
6SLAV-1 air & vacuum brake System	WABCO/USA	WDM1
28LV-1 air & vacuum brake System	,,	WDM2, WDM4, WDM6, WDM3, YDM3, YDM4, YDM5, WDS5, WDS6
28LAV-1 twin pipe dual brake System	,,	WDM2A, WDP1, WDP2, WDG2, WDM2c
KNORR air & vacuum brake System	M/S KNORR Germany	WDM3, WDS2, WDS3, WDS4, YDM1, YDM2, ZDM1, ZDM3
,, hydro pneumatic	,,	ZDM4, ZDM5
IRAB-1 brake system	RDSO	WDM2C, WDP2, WDG2
CCB System	KNORR BRAKE	WDG4, WDP4

IMPORTANT FEATURE OF 28LAV-1 (NYAB) BRAKE SYSTEM

1.Locomotive brakes may be applied with any desired pressure between the minimum and maximum. This pressure will be maintained automatically in the locomotive brake cylinders against normal leakage from them.

2. The locomotive brakes can be graduated on & off with either the automatic or the independent brake valve.

3. It is always possible to release the locomotive brakes with the independent brake valve, even when automatically applied.

4. The maximum braking position emergency, ensuring the shortest possible stops distance.

5. It is always possible to haul both vacuum / air brake trains.

6. Automatic brake application and power cut off with idle rpm of engine is always possible during train parting.

7.Multiple unit operation is also possible.

INDEPENDENT BRAKE SYSTEM

Introduction

Loco brake system is provided to stop the Locomotive, whenever it runs as light engine. It is purely compressed air brake system known as independent brake system. For this separate air circuit is provided in 28LAV-1 & IRAB-1 Brake system which is independent to other air circuit. SA9 Independent brake valve is provided in driving control stand for application & release of loco brake. Valve has three positions ie. quick release, release and application.

- Purpose of this system

Independent Brake System is designed to apply and release brake on locomotive. When locomotive is moving itself Independent Brake is applied.

- Loco brake valves

System consists SA9 Independent Brake valve, Double check valve and C2-Relay valve.

VACCUM BRAKE SYSTEM

- Purpose of this system

This system is designed to apply and release brakes on vacuum brake train. Which is achieved through A9 Automatic Brake valve.

- Vacuum brake system valves

System consists A9 Automatic Brake valve, VA1B Control valve and HS4 Control valve.

- Description of Vacuum Brake system

Locomotive and train has a long vacuum brake pipe, in which 56cm vac. is maintained through an exhauster unit. There is a VA1B control valve in between train pipe and exhauster unit, which controls 56cm vac.in train pipe. A9 automatic brake valve is provided in driving control stand to apply vacuum brake on train. When A9 handle is placed in application zone, train pipe vacuum drops and brakes are applied through vacuum cylinders of coaches.

The function of A9valve is to supply control pressure to Add.C2-Relay valve. The function of VA1Bcontrol valve is to maintain 56cm vac. in train pipe. The function of HS4 valve is to supply 1.7kg/cm2-air pressure to bottom chamber of VA1B control valve at port no.1. Other valves are provided in this circuit for MU operation. See line diagram of vacuum brake circuit.

BRAKE PIPE SYSTEM

- Introduction

BP system is introduced to run Air Brake train, where train brake is controlled through BP pipe instead of vacuum pipe. Additional C2-Relay valve is introduced in this system to supply sufficient air to BP system.

- BP system valves

BP system consists A9 Automatic brake valve, MU2B valve, Add./C2-Relay valve, Air flow measuring valve,R-6 Relay air valve and Air flow indicator.

- Purpose of this system

This system is introduced to run air brake train. Air Brake system can sustain better brake power and can haul a long train.

- MR air is connected to A9valve at port 30 and Add./C2-Relay valve at port 1. Normally A9 handle is kept at release position and maintains 5kg/cm2-air pressure in brake pipe. In this position brakes are found released position. When A9handle is moved to application zone, B P pressure drops through Add. C2-Relay valve, port 3 is connected to exhaust. In this condition brakes are applied.

Brake release

When A9 handle is moved to release position, Add. C2-Relay valve port3 is connected to port1 and B P pipe is charged to 5kg/ cm2 and brakes are released

FEED PIPE SYSTEM

Introduction

Air Brake system has two brake pipes, BP pipe and FP pipe. BP Pipe is provided for brake application and release where as FP Pipe is provided to help in release time.

- FP system valves

System consists Feed valve and Duplex check valve, which are connected from MR-1.

- Purpose of the system

Feed Pipe system is introduced to reduced the release time after brake application in air brake trains.

- Description of the system

FP System is charged 6kg/cm2 through MR pipe and Feed valve. Air flows from MR-1 to Duplex check valve, which allows air to outlet when MR pressure becomes more than 5kg/cm2. Air reaches directly to Feed valve through cut-out cock. Feed valve supply air to feed pipe at 6kg/cm2. How Feed valve reduces the MR pressure to 6kg/cm2 see the internal function of the valve.

PROPORTIONAL BRAKE SYSTEM

Introduction

In prop/brake system locomotive brake works in proportion to train brake. If train brake is partially applied to slow down the train in proportion to that loco brake will be applied. This work is done through proportionate brake valve.

- Proportionate brake system valves

Proportionate brake system consists SA9valve, MU2Bvalve, Proportionate brake valve, C2 Relay valve, Double check valve.

- Purpose of this system

System is designed for Locomotive brake application during train brake application through A9 handle. This is known as synchronising brake system also.

- Description of the system

In this system proportionate valve is connected to vacuum pipe and MR pipe, when vacuum is dropped to zero for train brake application, at the same time vacuum of prop/valve chamber A is also drops to zero. See the line diagram of proportionate brake system. Then Prop/valve supplies control /pilot air pressure to C2-Relay air valve and loco brakes are applied.

To avoid loco brake, in SA9 valve Quick Release position is provided. If handle is moved to Quick release position then loco brake will not take place. Prop/valve has two vac./chambers, which are connected to SA9 valve port no.1&7. At Q/Rel. position both ports are connected causing both chamber of prop/valve equalized. So there is no action inside the valve.

In IRAB-1 Brake system C3W-Distributor valve is provided in place of proportionate brake valve, which senses the BP pressure.

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