

SPL FEATURES OF GM

OBJECTIVES

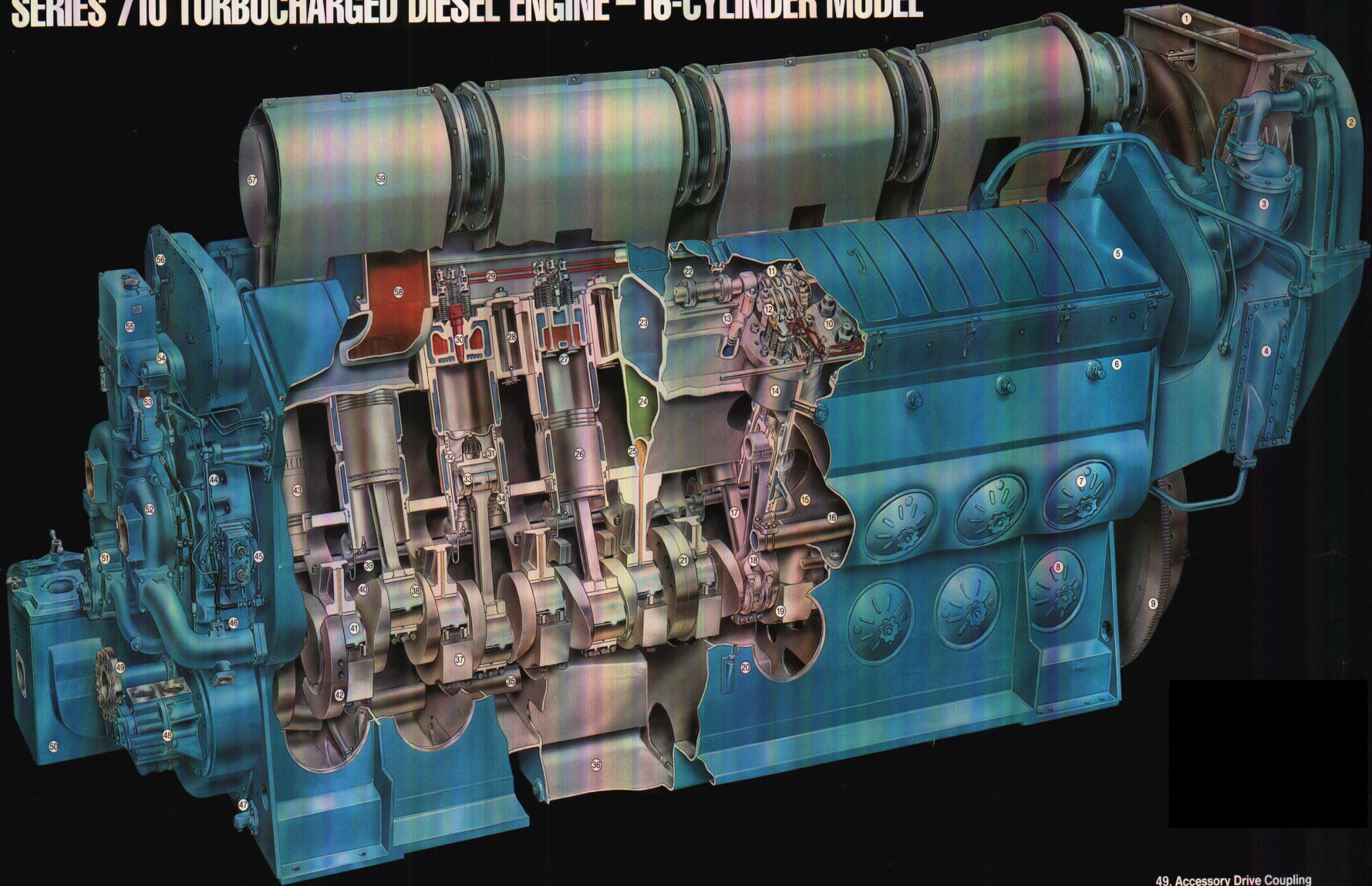
- Brief History
- Special features of GM.
- Comparison- ALCO engine Vs GM engine.
- EMD layout.
- Compartments of EMD Loco.
- Major components and their role .

GT46 - A VARIANT OF SD70

GT46MAC



SERIES 710 TURBOCHARGED DIESEL ENGINE – 16-CYLINDER MODEL



1. Exhaust Outlet
2. Turbocharger
3. Lube Oil Separator
4. Turbocharger Aftercooler
5. Top Deck Cover
6. Cylinder Relief Valve
7. Crankcase Handhole Cover
8. Oil Pan Handhole Cover
9. Ring Gear
10. Cylinder Head Retainer Plate

11. Rocker Arms-
Injector and Exhaust Valves
12. Exhaust Valve Bridge
13. Cooling Water Discharge Elbow
14. Cylinder Head
15. Cooling Water Inlet Jumper Line
16. Cooling Water Manifold
17. Connecting Rod - Blade
18. Connecting Rod - Fork
19. Fork Rod Basket

20. Oil Level Gauge
21. Crankshaft
22. Camshaft
23. Water Discharge Manifold
24. Airbox - Inner Vee
25. Main Lube Oil Gallery
26. "Fire-Ring" Piston
27. Exhaust Valves
28. Cylinder Head Retainer Bolt
29. Fuel Manifold

30. Fuel Injector
31. Piston Carrier
32. Thrust Washer - Carrier/Piston
33. Piston Carrier Insert Bearing
34. "Rocking" Piston Pin
35. Scavenging Oil Pump Intake
36. Oil Pan Sump
37. Main Bearing Cap
38. Connecting Rod Bearing
39. Piston Cooling Oil Manifold

40. Piston Cooling Oil Pipe
41. Main Bearing
42. Crankshaft Counterweight
43. Cylinder Liner
44. Injector Control Shaft Lever
45. Detectors -
Low Water and Crankcase Pressure
46. Low Water Detector Test Cock
47. Airbox Drain
48. Scavenging Oil Pump

49. Accessory Drive Coupling
50. Lube Oil Strainer
51. Main Lube/Piston Cooling Oil Pump
52. Cooling Water Pump
53. Governor Terminal Shaft Scale
54. Governor Integral Vane Servo
55. Governor
56. Overspeed Trip Lever
57. Exhaust Manifold
58. Cylinder Exhaust Outlet
59. Exhaust Manifold Heat Shield

Nomenclature

16 710 -G3-B

NO. OF CYL.

SWEPT VOLUME

RAIL ROAD UPGRADED
TURBO CHRGED ENG

NEW GENRATION
FUEL ECONOMY
ENGINE

I-09- A - 001

INDIA

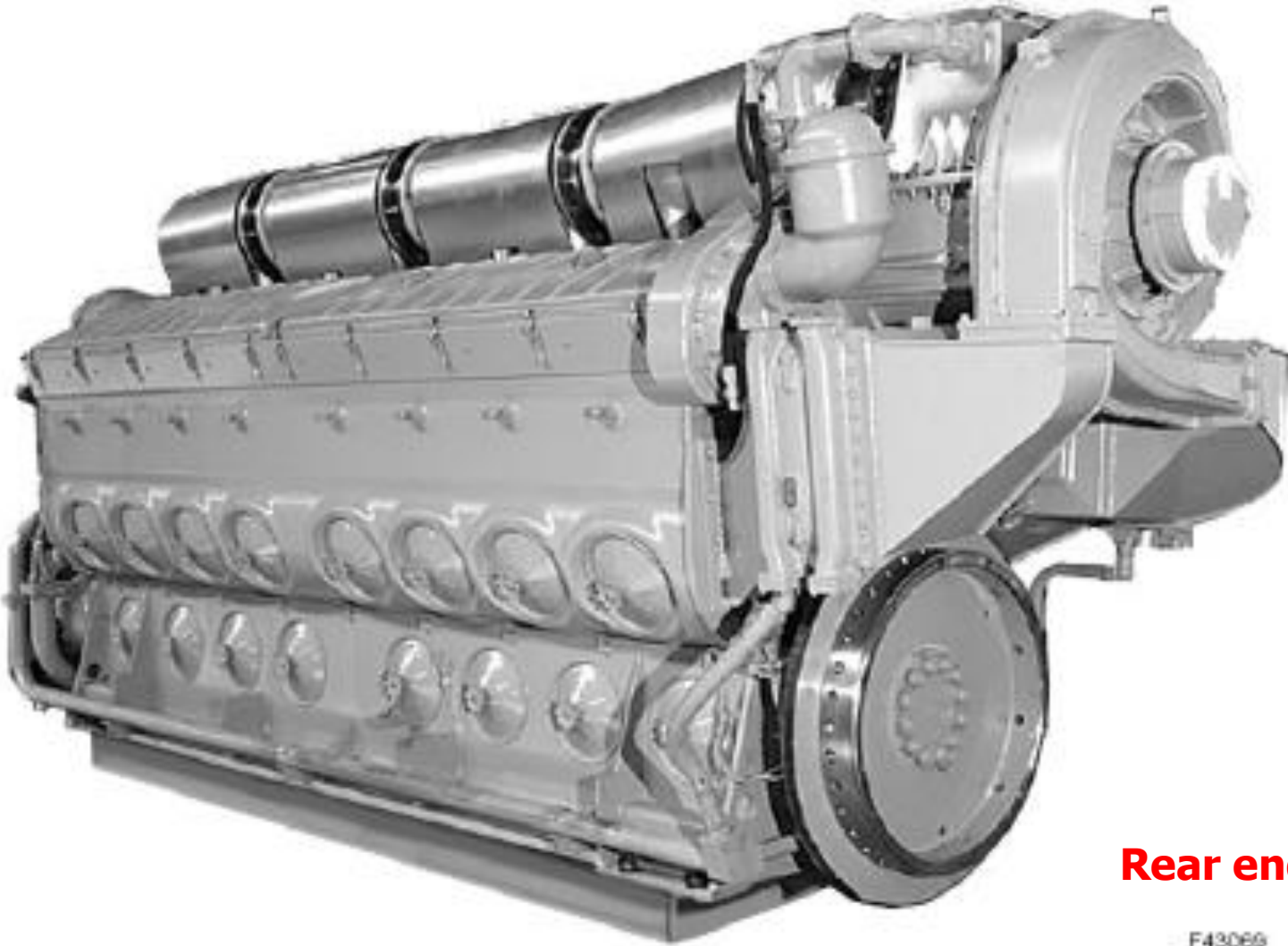
YEAR

MONTH

ENG. SL. NO.

ACCESSORY END

TURBO END



**Front
end**

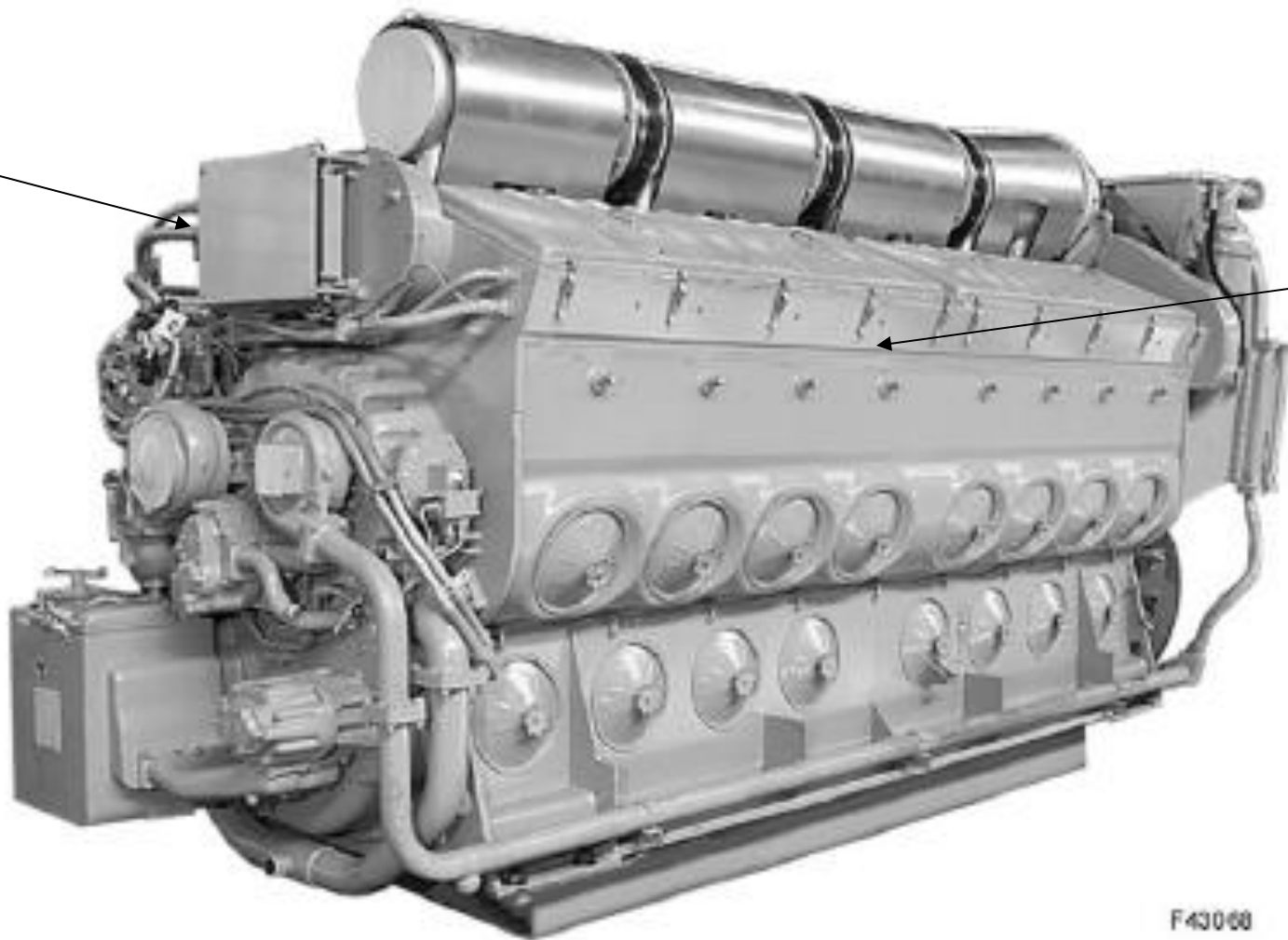
Rear end

FRONT
END

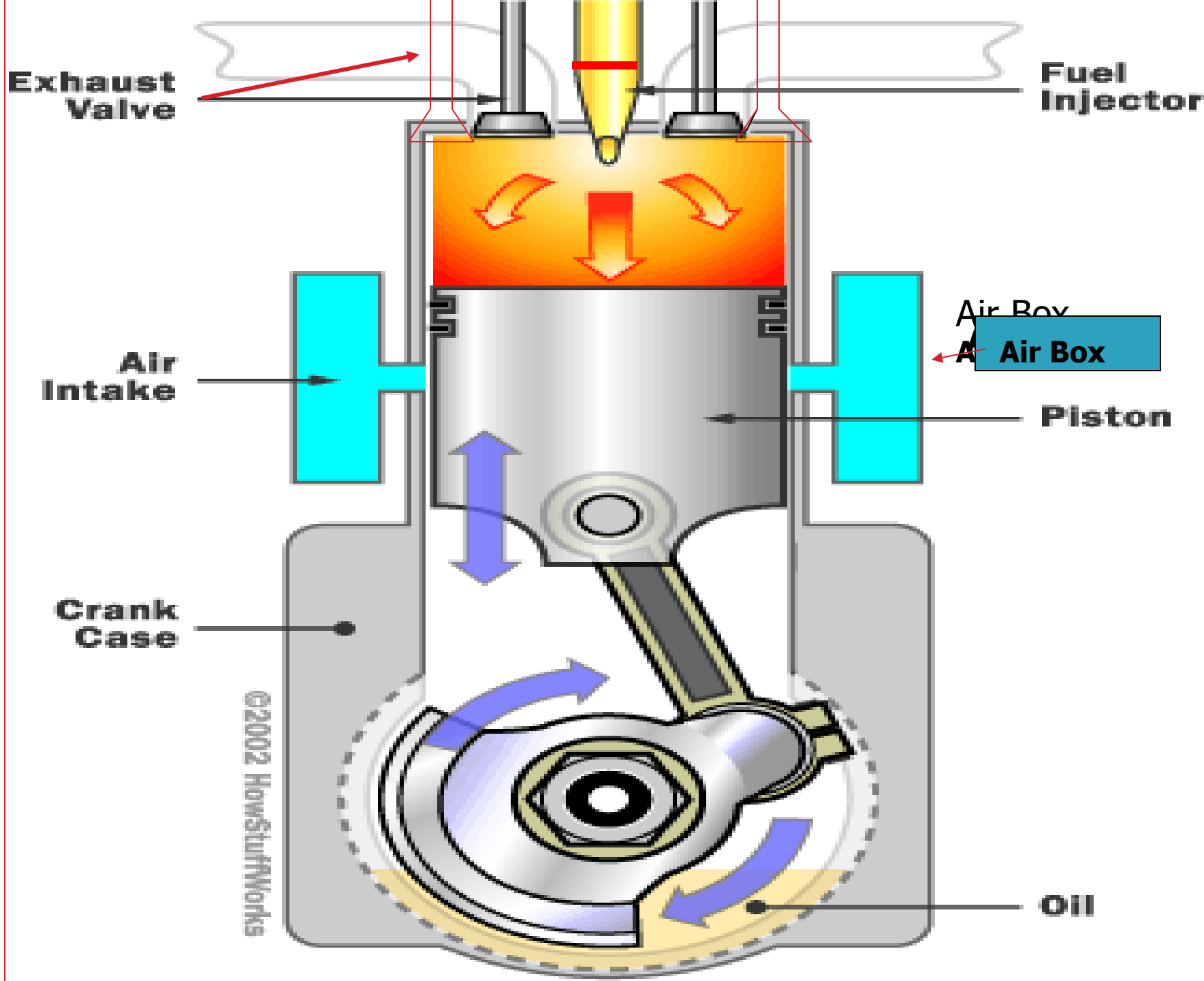
REAR END

Right
bank

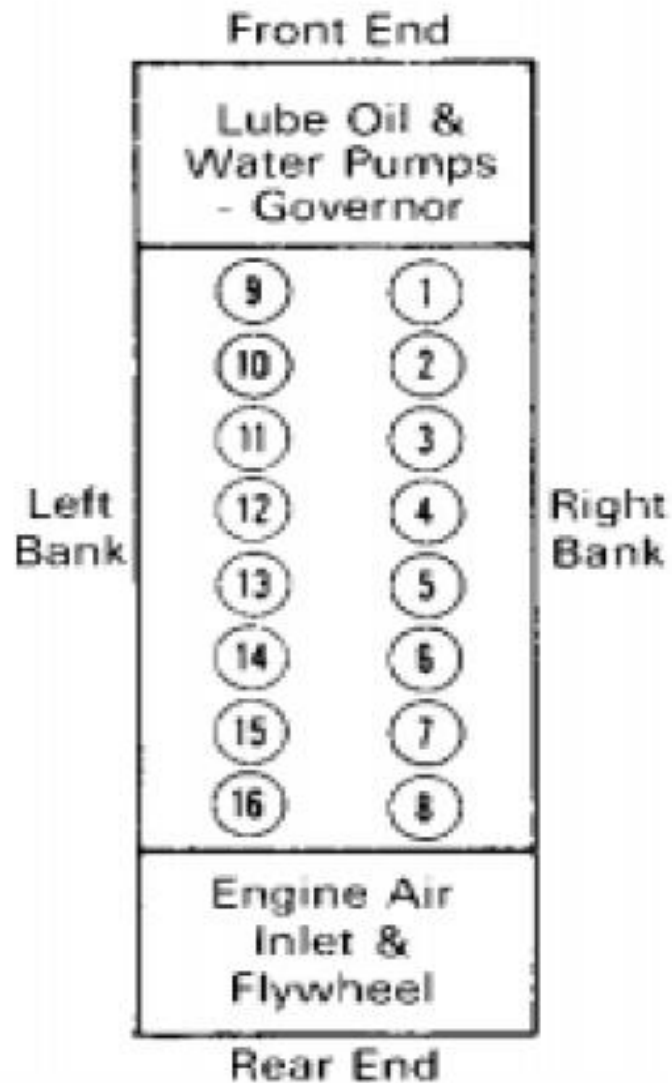
Left bank



F43068



FIRING ORDER



Firing order

1,8,9,16,3,6,11,14,4,5,12,13,2,7,10,15

DESIGN



- **Bore** = 230.1 mm
- **Stroke** = 279.4 mm
- **CR** = 16:1
- **PFP** = 127.6 bar (1850 psi)
- **BMEP** = 11.23 bar (163 psi)
- Mean Piston Speed = 8.38 m/sec

INLET / EXHAUST TIMING

Inlet Ports - Open 43.5° BBDC
Close 43.5° ABDC

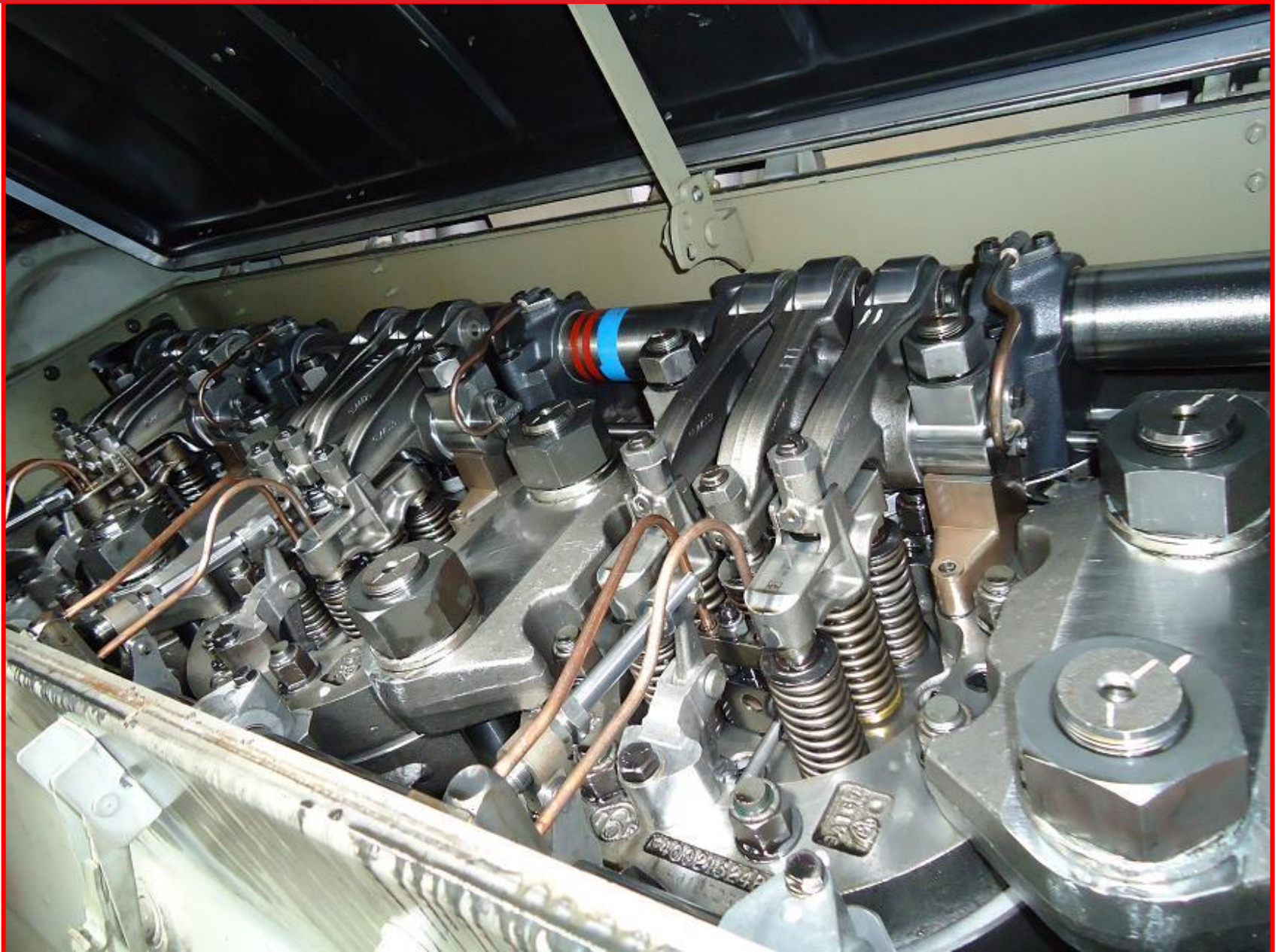
Exhaust Valve - Open 109° ATDC
Close 67° ABDC

Weight

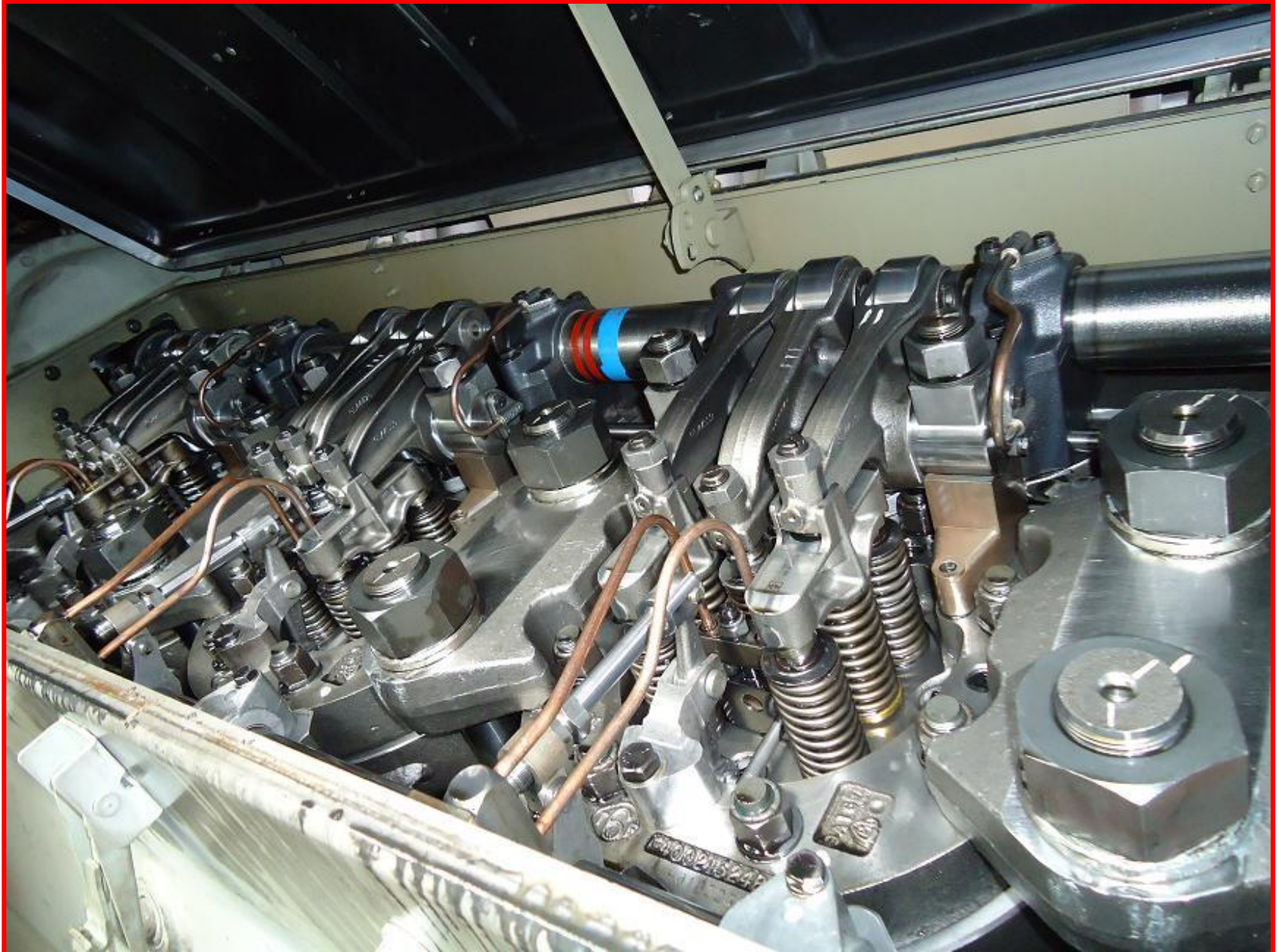
17962 Kg

{ Weight of Engine + Lube Oil + water }

2 stroke fuel efficient engine



POWER ASSEMBLY CHANGED AS A SET



UNIT INJECTOR

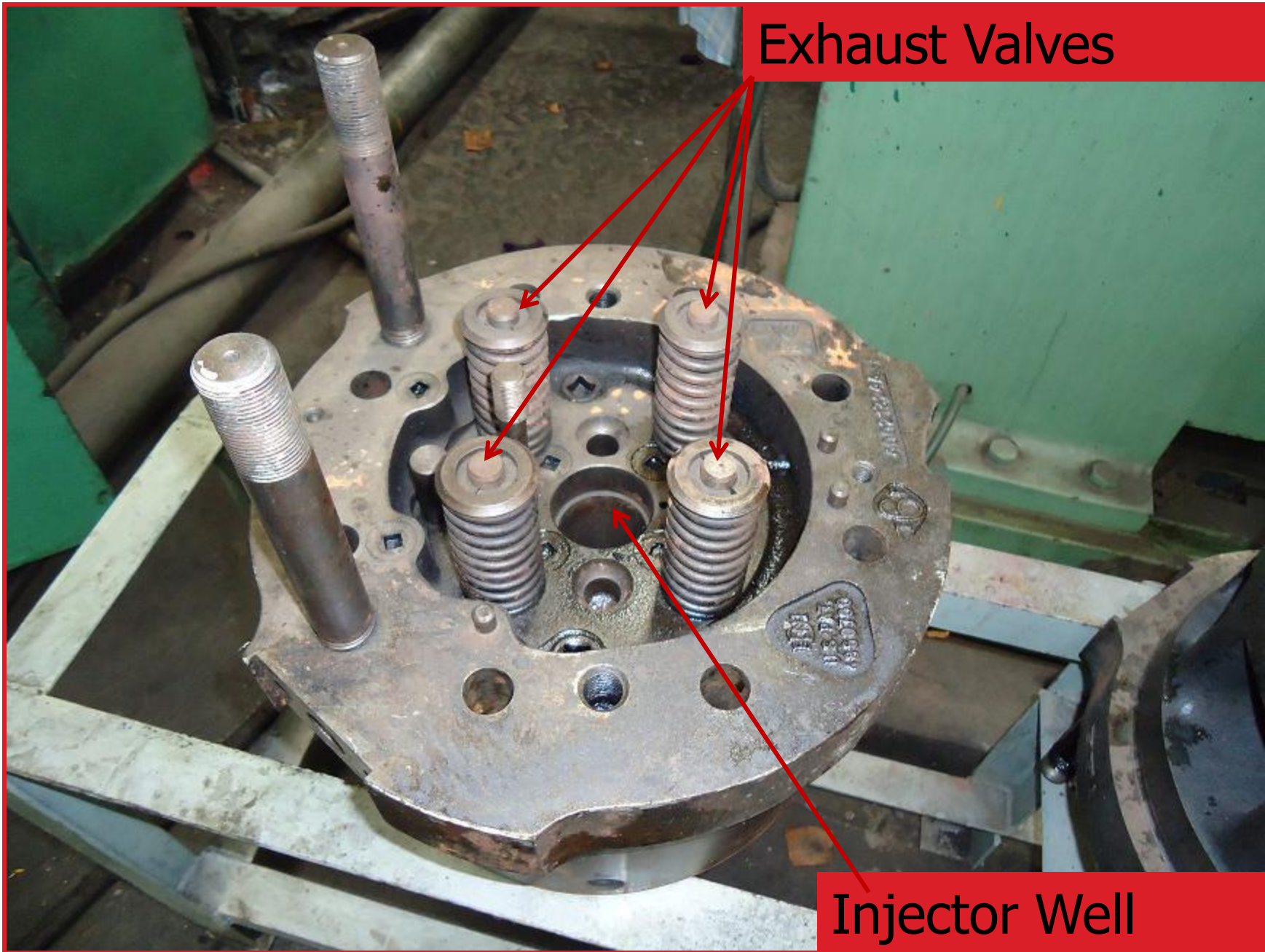


Fuel injection



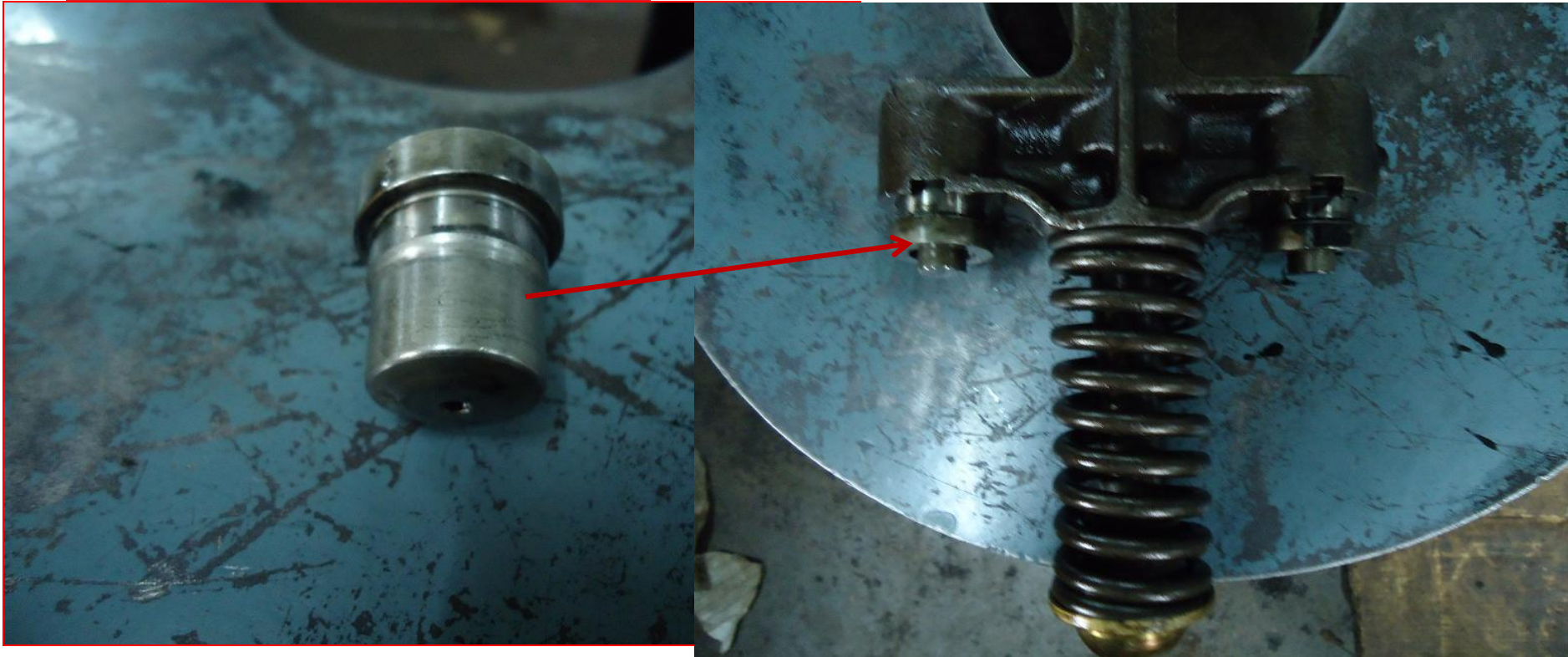
- ✓ Unit fuel injectors
- ✓ Nozzle holes – 7 holes , 0.39 mm \varnothing
- ✓ Spray angle - 150°
- ✓ Nozzle opening Pr – 197 to 239 kgf/cm²
- ✓ Pump plunger $\varnothing = 14.29$ mm

Exhaust Valves

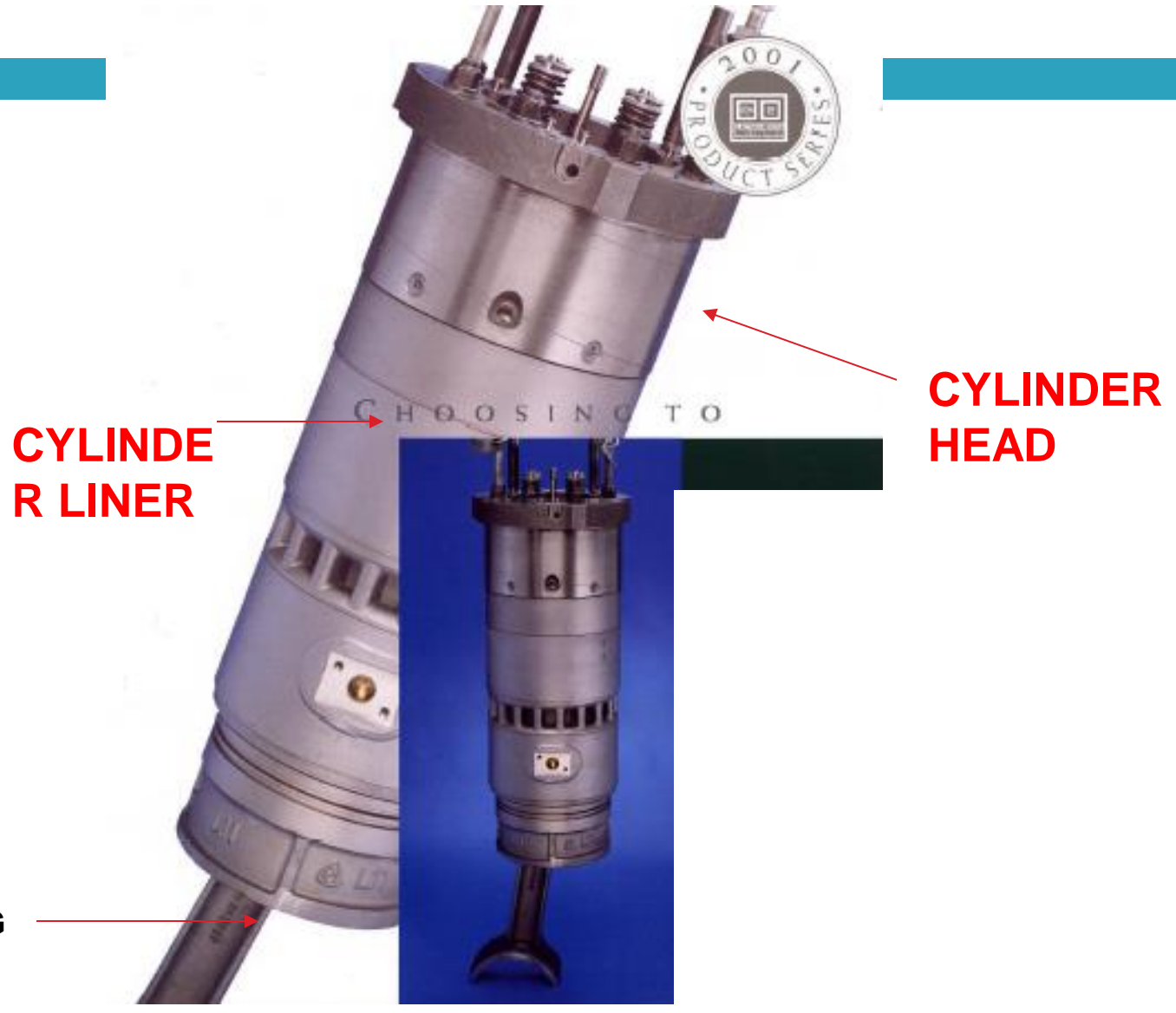


Injector Well

LASH MECHANISM



POWER ASSEMBLY



**CYLINDER
LINER**

**CYLINDER
HEAD**

**CONNECTING
ROD
BLADE/FORK**

GOVERNOR LAY SHAFT

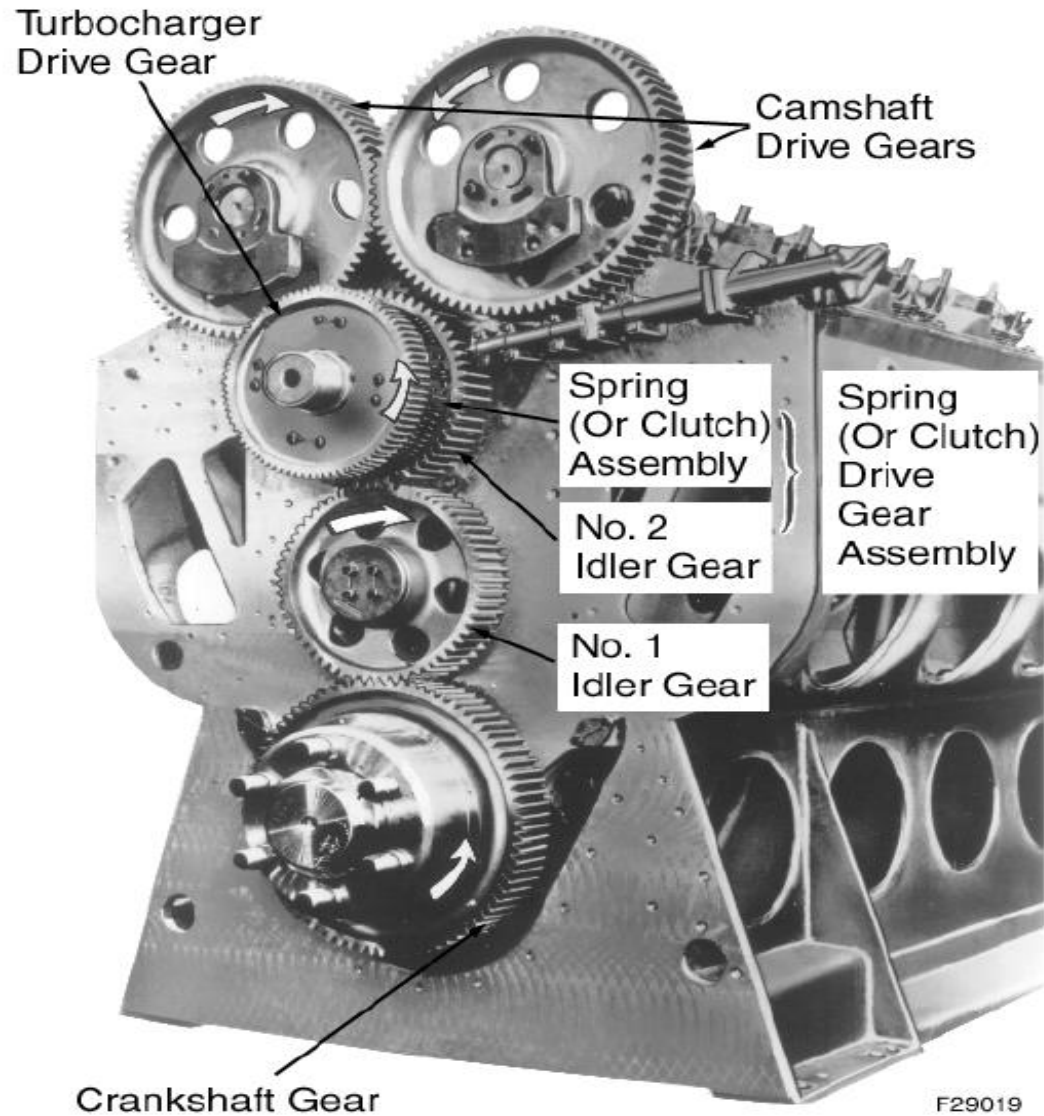


Upgrading of EMD 710 G3B

Notch	RPM	Load (N)	Power (hp)
*8 th (C)	950	38870	4950
*8 th (B)	950	35337	4500
*8 th (A)	904	33008	4000
7 th	820	32460	3568
6 th	730	27612	2702
5 th	651	21406	1868
4 th	568	18440	1404
3 rd	490	15020	988
2 nd	343	9813	452
1 st	270	5858	212
Idle	200	5595	150

* (A) - Existing configuration, (B) – Increase in hp to 4500, (C) – 10% Overload

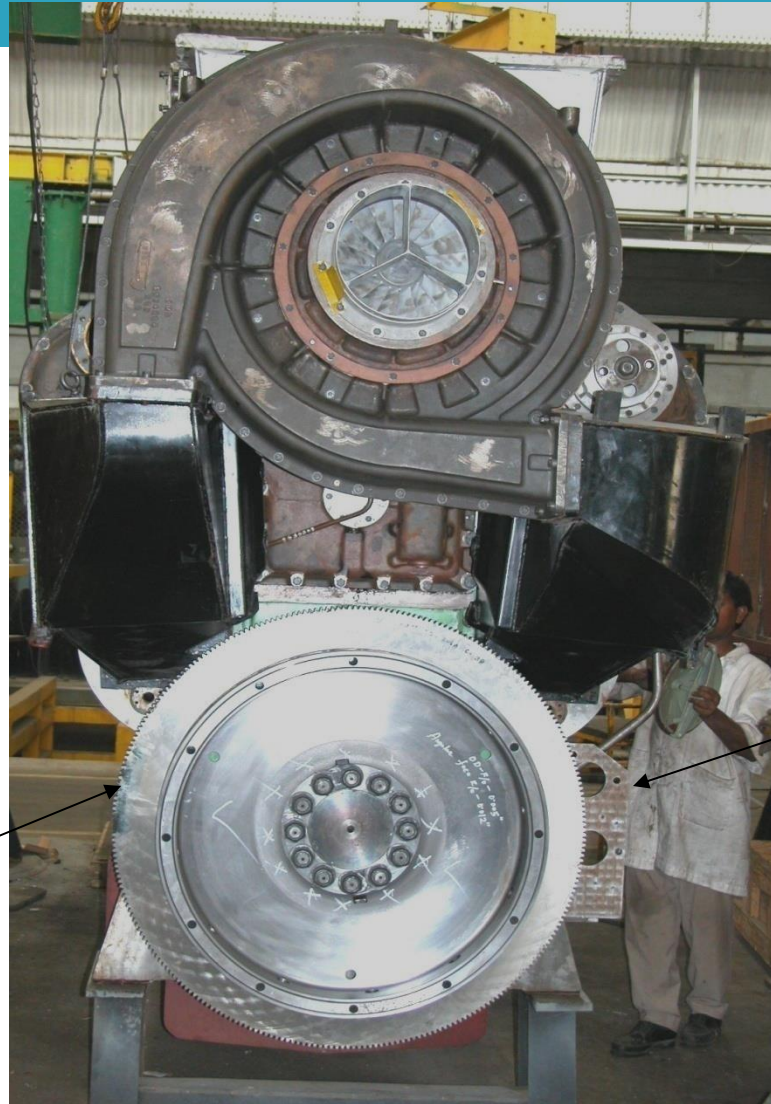
GEAR TRAIN



F29019

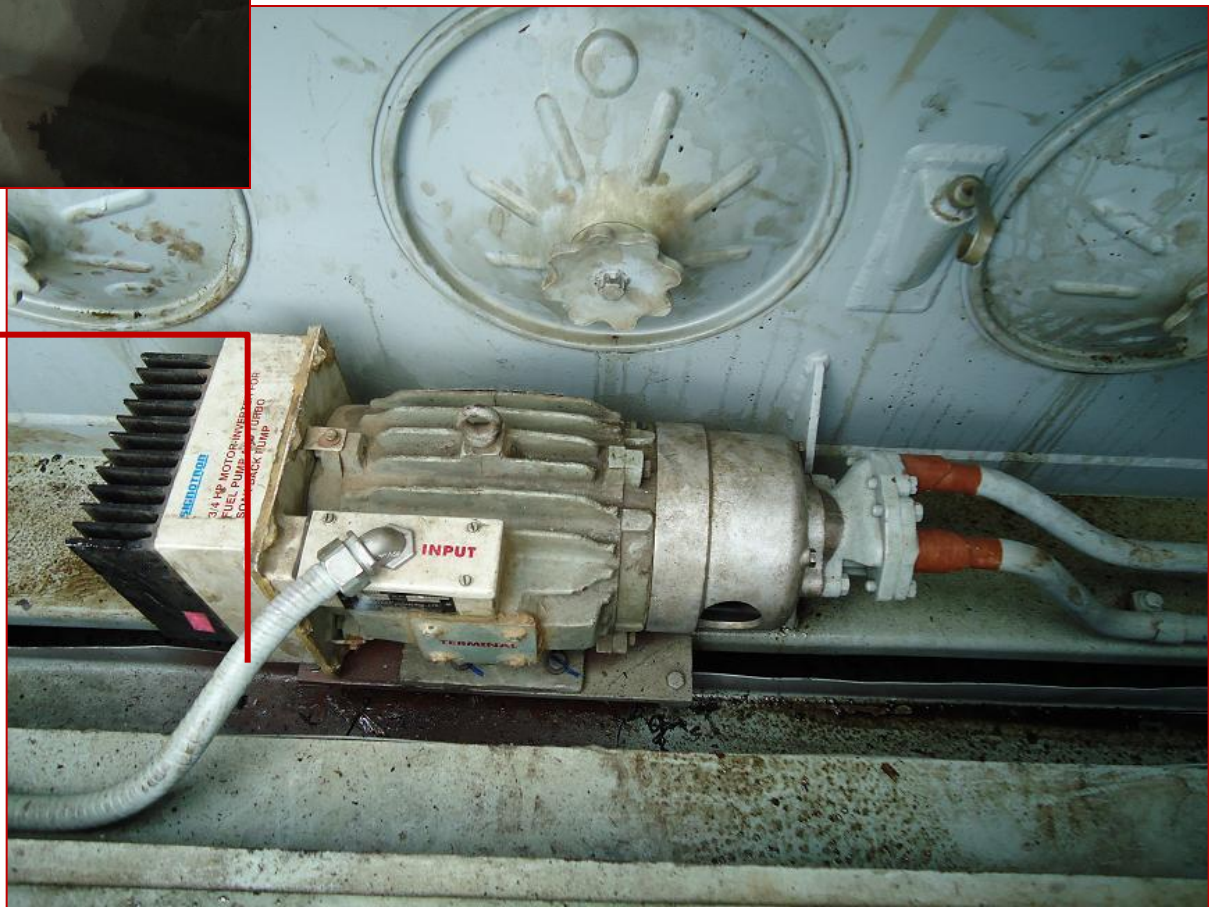
Starting Arrangement

RING GEAR



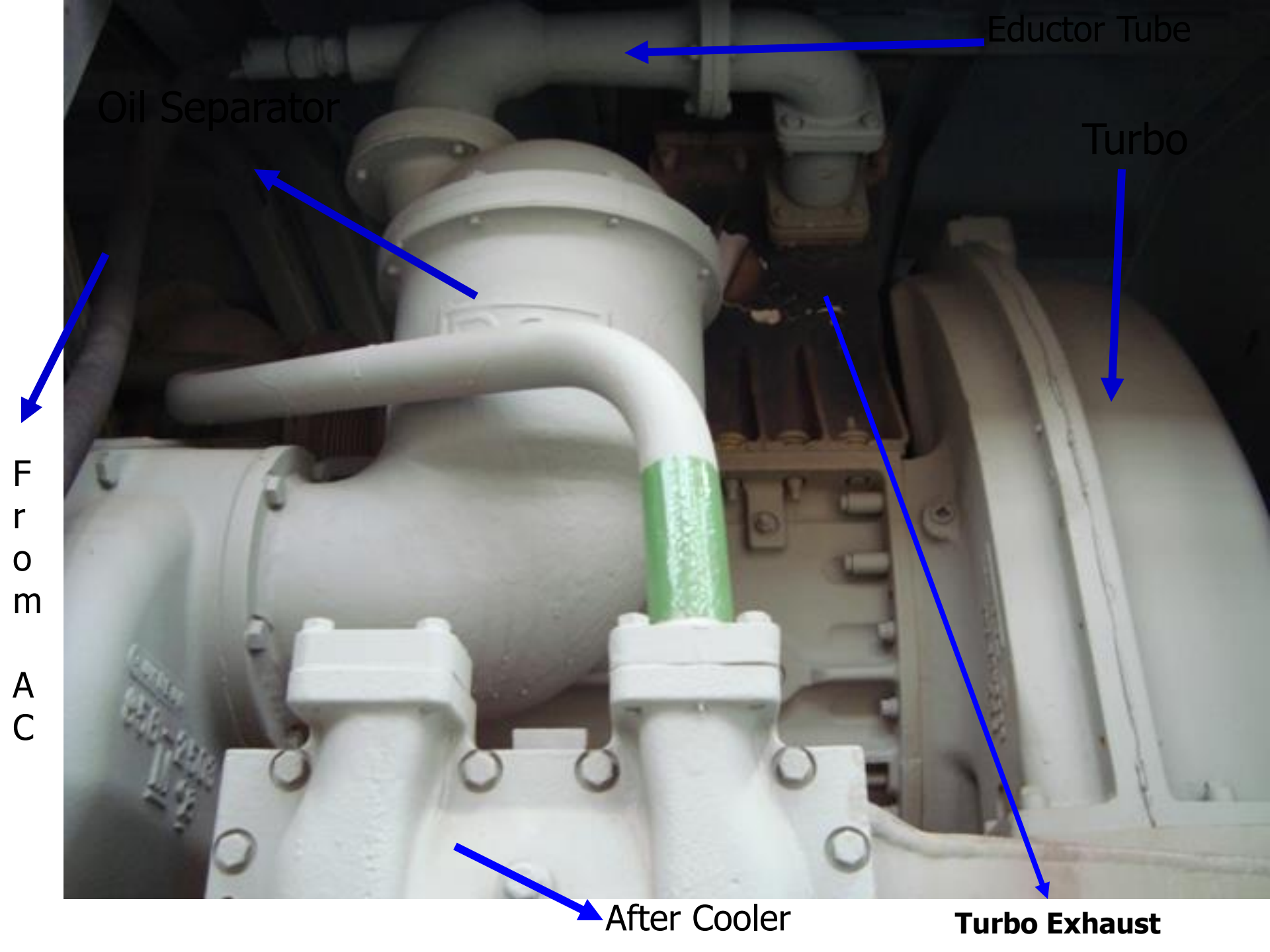
STARTER MOTOR
MOUNTING
BRACKET

SOAK BACK PUMP & FILTER



EDUCTOR CCV MECHANISM





Eductor Tube

Oil Separator

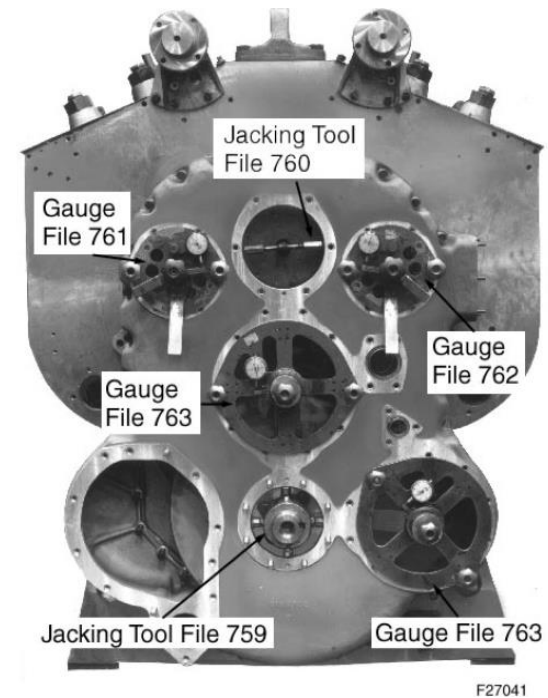
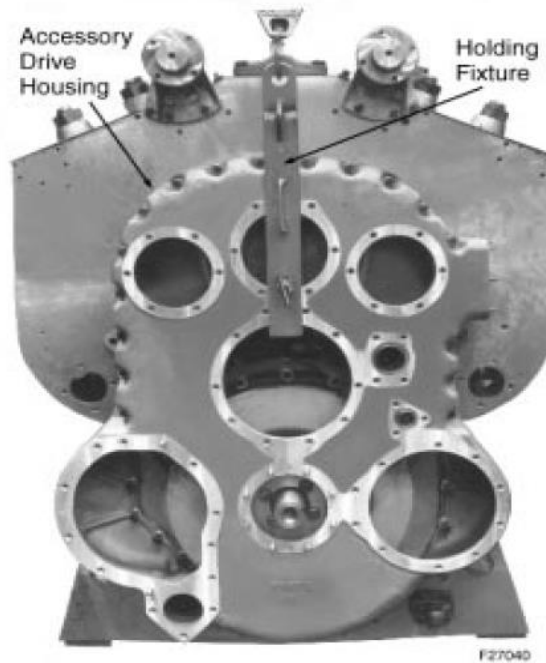
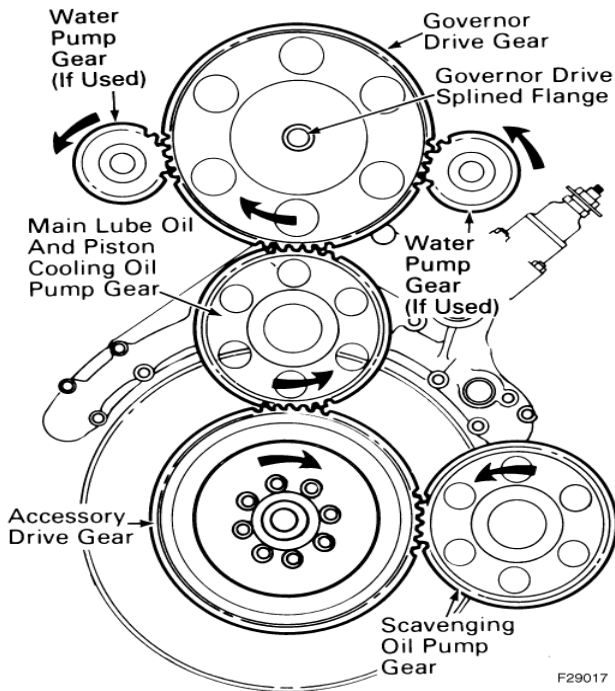
Turbo

F
R
O
M
A
C

After Cooler

Turbo Exhaust

Accessory end Gear train



Exhaust manifold

governor



Water pump

SECONDARY FILTER

Main lube oil pump

FUEL INLET MANIFOLD

Scavenging pump

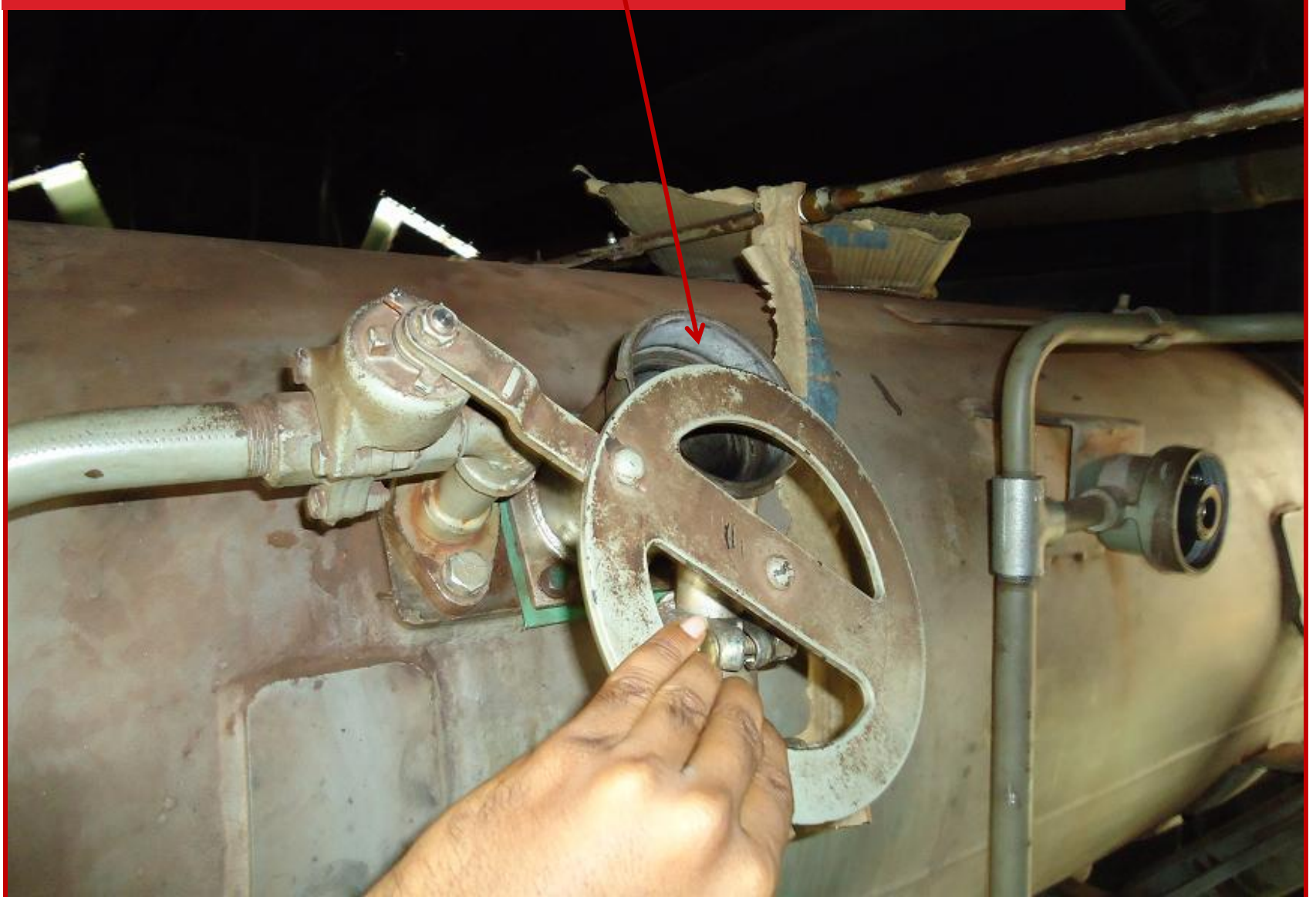
LO.strainer

Water Pumps

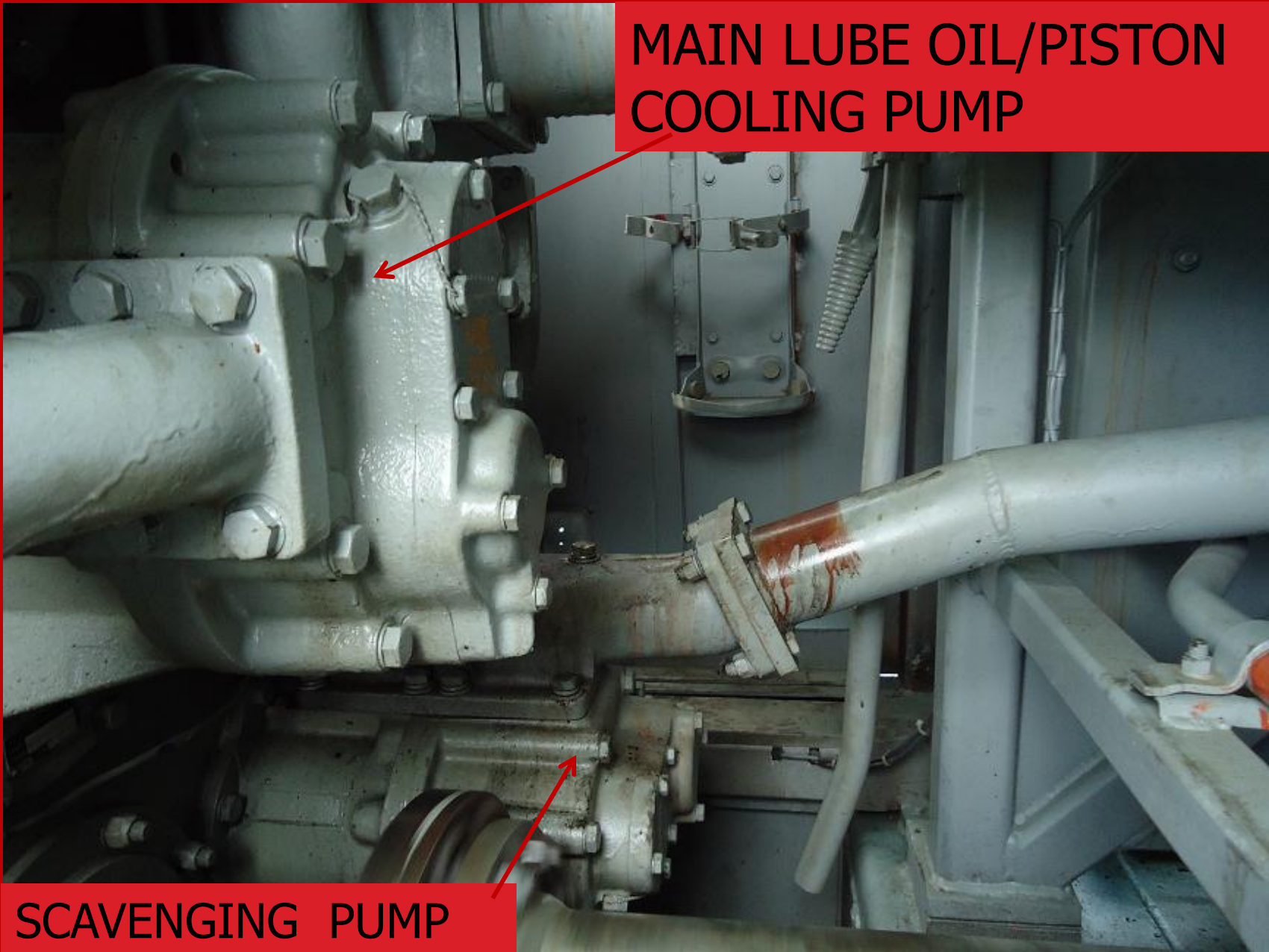
Water discharge



WATER PRESSURE RELEASE MECHANISM

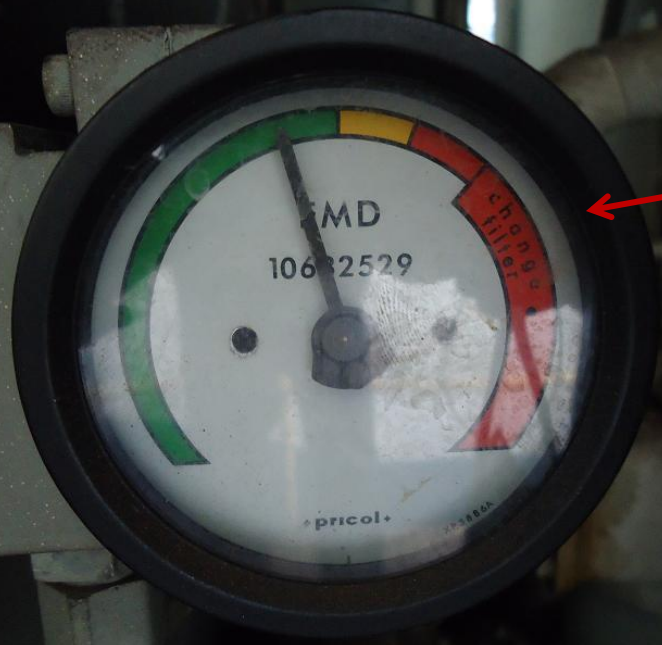


**MAIN LUBE OIL/PISTON
COOLING PUMP**

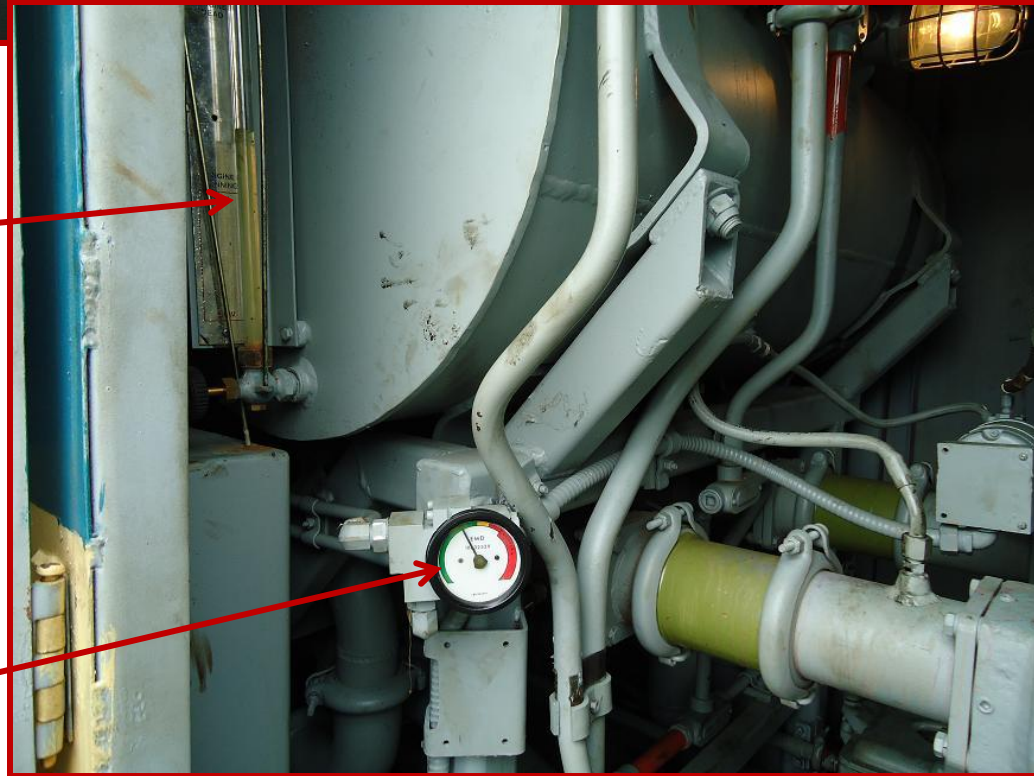


SCAVENGING PUMP

LUBE OIL FILTER
ELEMENT
CONDITION GUAGE

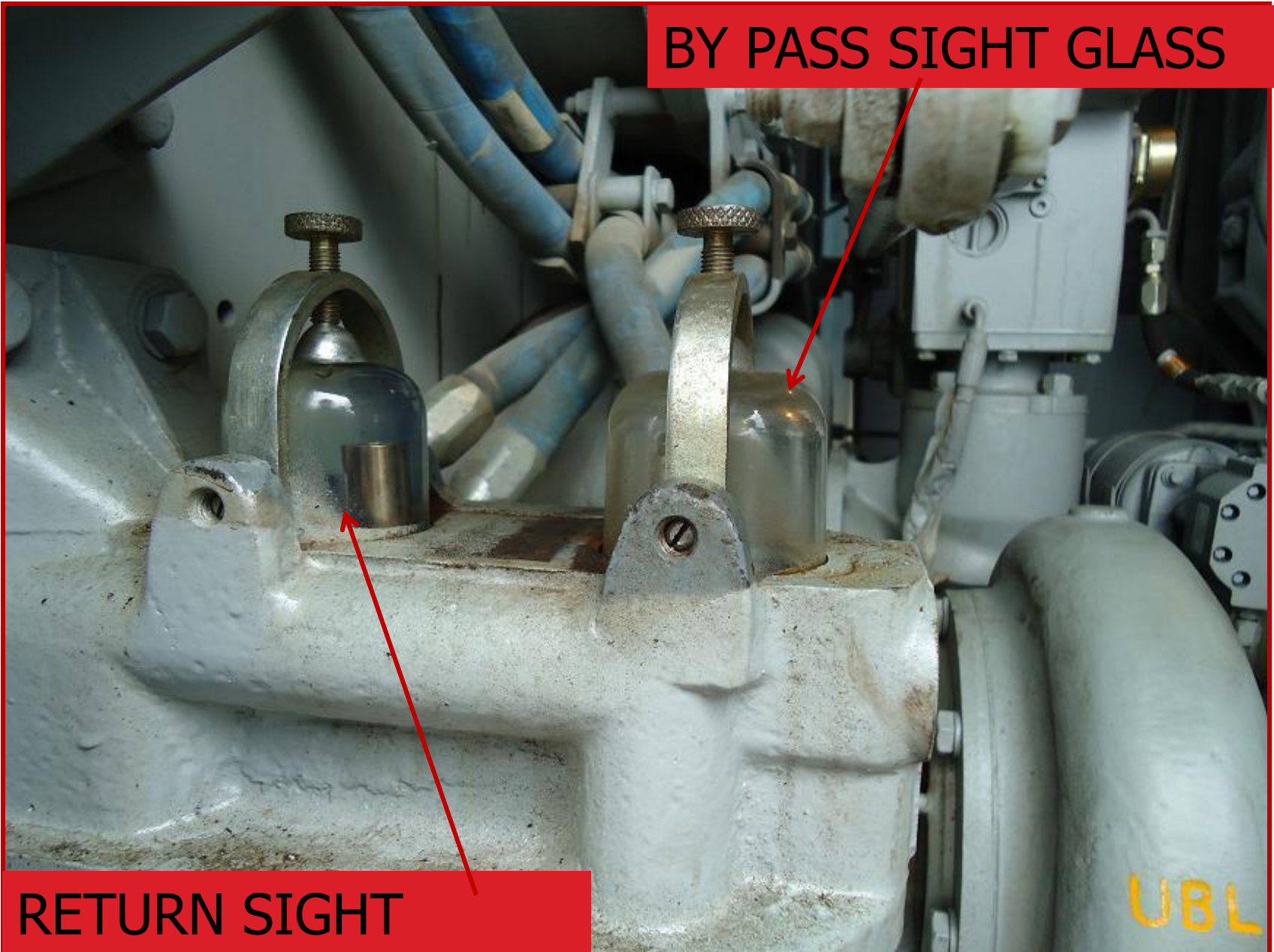


WATER SIGHT GLASS



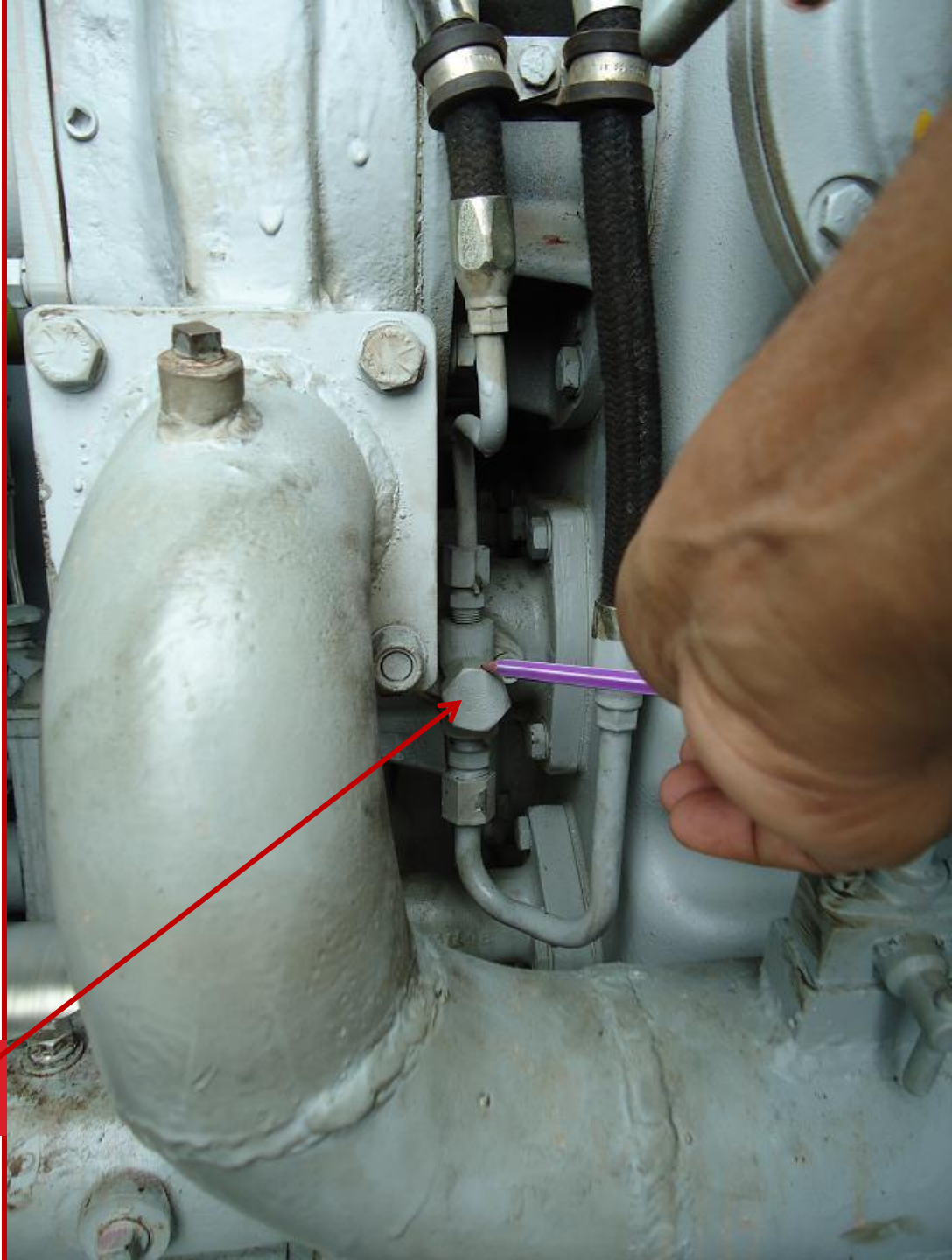
FUELOIL FILTER ELEMENT
CONDITION GUAGE

BY PASS SIGHT GLASS



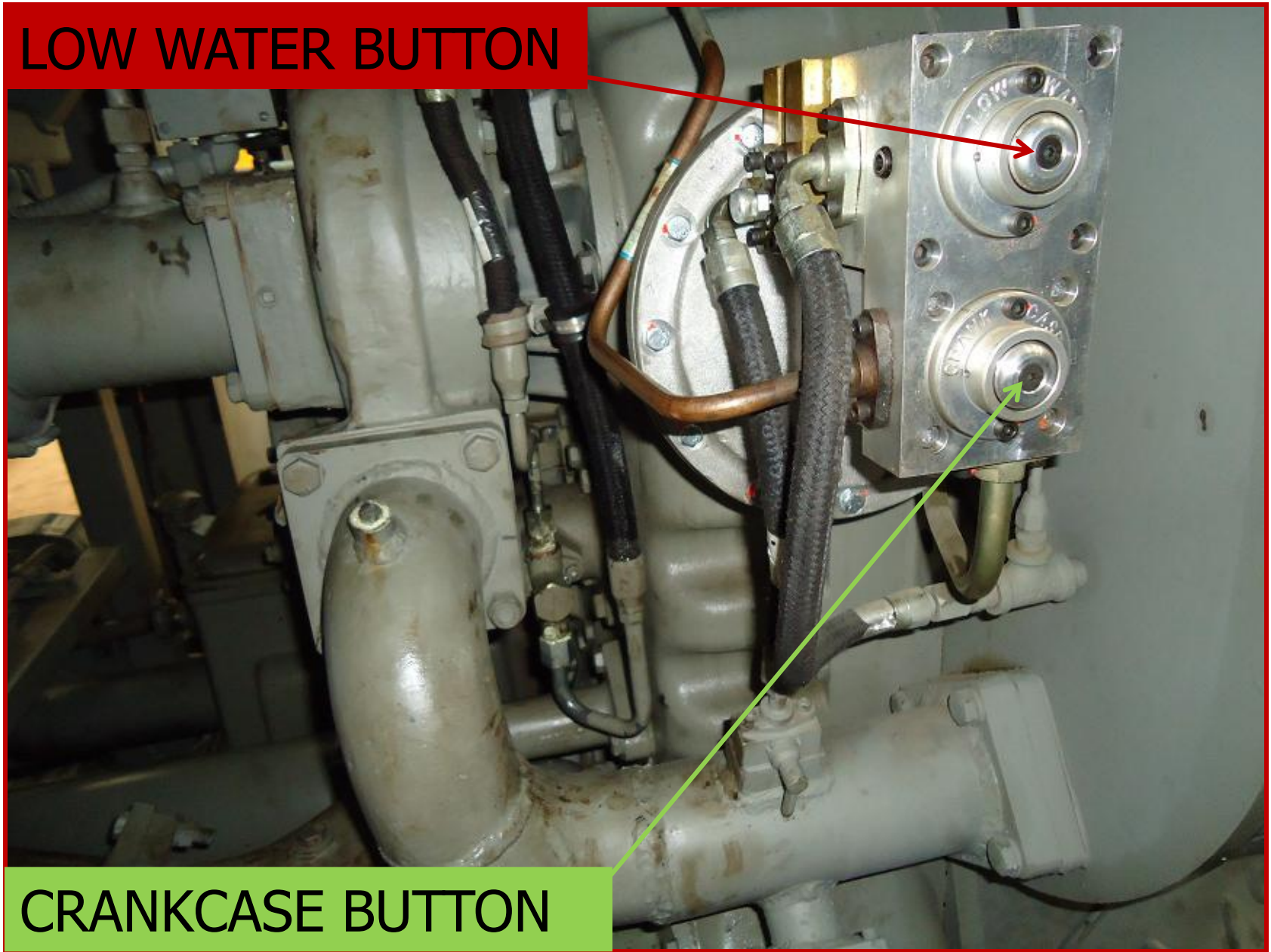
**RETURN SIGHT
GLASS**

UBL



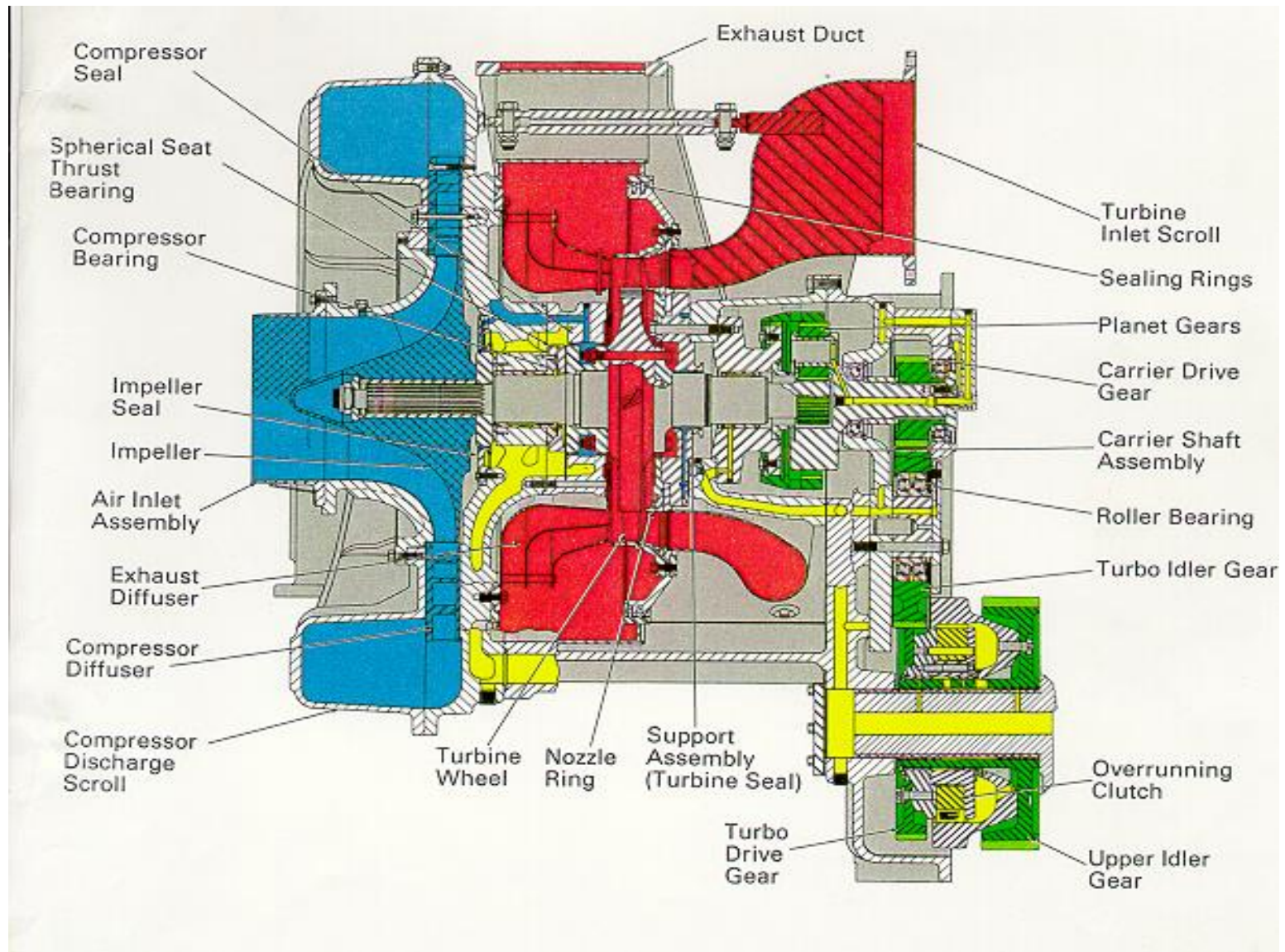
HOT OIL DETECTOR

LOW WATER BUTTON



CRANKCASE BUTTON

710 EMD Turbocharger



WATER COOLED COMPRESSOR







12022

GAP
Front -
2000



BASICS

- 710 G3B type 16 cylinder, 2-stroke diesel engine
- Main Computer- EM2000
- Computer controlled traction system
- Computer controlled Brake system
- High adhesion
- Fuel efficient
- Low maintenance

Continued....

- High adhesion levels –
- high tractive effort
- Excellent dynamic brake
- High availability and reliability
- Operator friendliness
- alerter system
- Sealed twin beam headlight
- Easy interaction and guidance for trouble shooting (through EM2000)
- Ease of verification of safety devices

SPECIAL FEATURES

- 710 G 3B FUEL EFFICIENT & LOW MAINTENANCE ENGINE WITH THE FOLLOWING FEATURES:
 - Laser hardened cylinder liners.
 - Unit fuel injectors.
 - Inconel valves and Valve bridge with hydraulic lash adjuster.
 - Overhead camshaft- No need of push rod and FIP support.
 - Durable crankcase and piston structure.
 - High efficient Turbo with external over running clutch arrangement.

FEATURES..

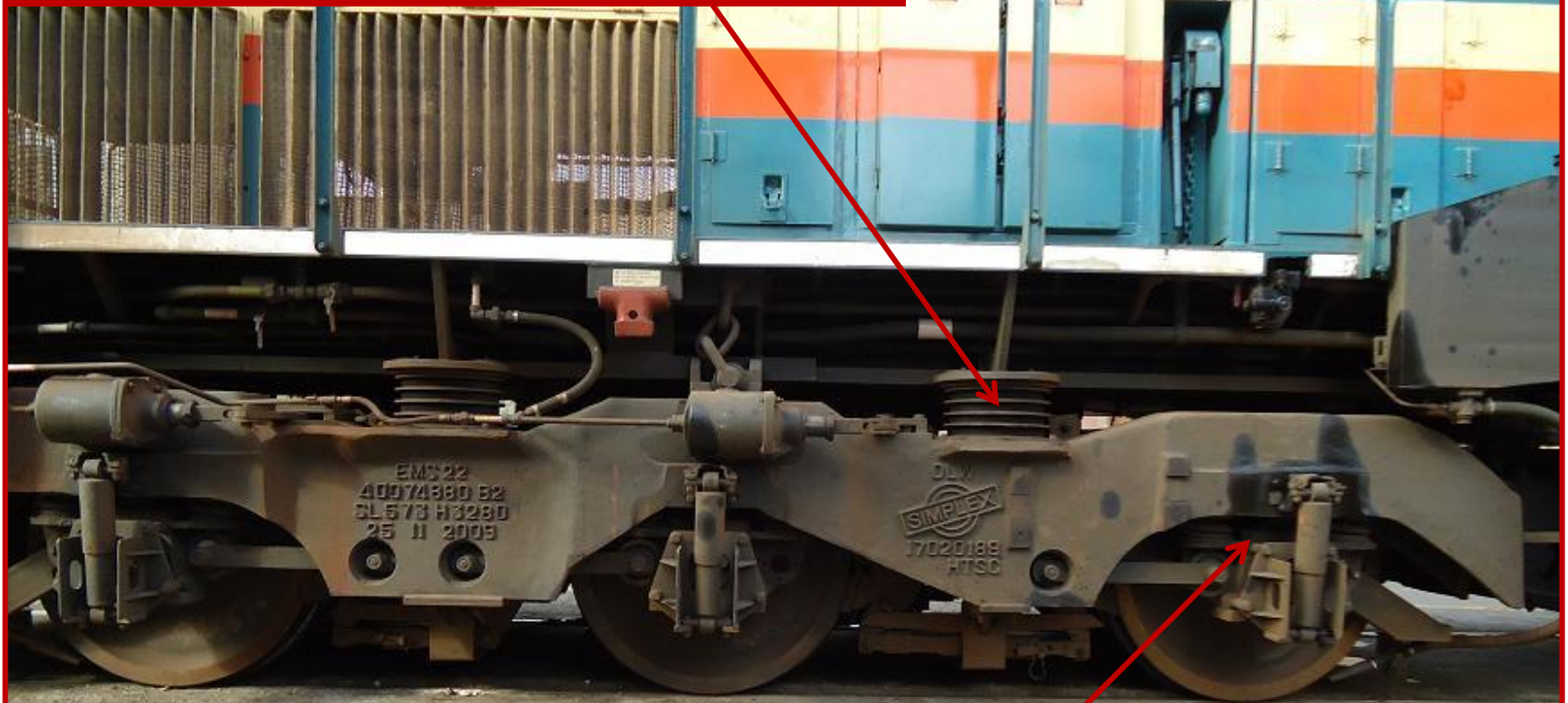
- ❑ IMPROVED MECHANICAL SYSTEMS
 - ❑ Microprocessor controlled Engine cooling system.
 - Radiator fan drive through microprocessor controlled electrical Motors (Two speed fans 2 Nos)
 - Mechanical bonded radiator core.
 - ❑ Improved Primary Filtration.
 - ❑ Efficient Secondary Filtration.
 - Fibre glass filter element for engine. (condition monitored on computer).

FEATURES..

▣ HTSC bogie

- Uni-directional Traction motor.
- No bolster ,Low centre pivot.
- Soft primary –Helical spring
- Stiffer secondary –Rubber spring.
- Hydraulic dumping (primary & secondary)
- Low maintenance (No pedestal & pivot).

SECONDARY SUSPENSION



PRIMARY SUSPENSION

FEATURES..

- AC-AC TRANSMISSION with the following modern features-
 - Computerised Traction control, resulting in High adhesion and Tractive effort.
 - Maintenance-free traction motors with roller bearing suspension.
 - No limitation of minimum continuous speed.
 - High reliability and availability.
 - Lower rolling resistance and higher transmission efficiency.

GEAR CASE OIL LUBRICATED T/M BEARING



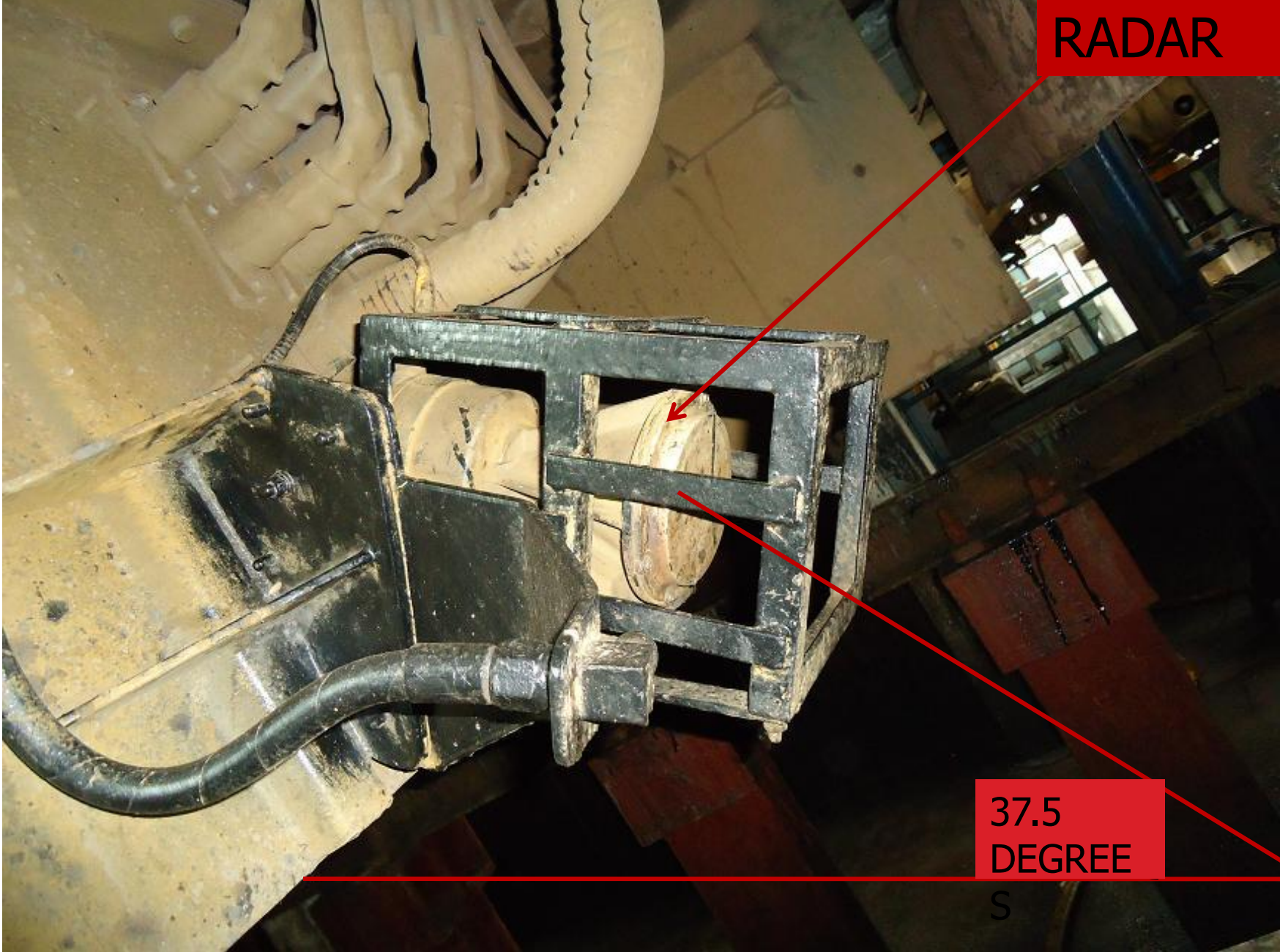
FEATURES..

- EM - 2000 COMPUTER CONTROL with the following advanced features:
 - To control other systems and protective functions as programmed in **display diagnostic systems**.
 - **Excitation control**, to determine engine power level as per driver's demand through throttle handle and also to match electrical loading with engine's capability.
 - Monitors critical function in **locomotive power system** and provide display message and audible alarm, if necessary, in case of faults.

FEATURE..

- **COMPUTER CONTROL BRAKE SYSTEM**
 - Self test feature –checks all components.
 - Pin points the location of failure fast.
 - Blended brake/Vigilance control-No additional valves.
 - Flexibility for future system upgrades.
 - Integration with controls of other locos possible.

RADAR



37.5
DEGREE

S

SCHEDULE MAINTENANCE

- Trip/First schedule – After 30/90 days .
- Yearly schedule – 6 years
- 3 yearly schedule – 12 years.
- POH- 18 years

VARIANTS OF GM

- WDG4(4000HP)
 - ▣ WDG4B(4500HP)
 - ▣ WDG4D(4500HP)
- WDG5(5000HP)
- WDG5B (5500HP)
- WDP4(4000HP)
 - ▣ WDP4B(4500HP)
 - ▣ WDP4B(4500HP)
 - ▣ WDP4D(4500HP)

ALCO –GM COMPARISION

GM/EMD

- ❑ 4000 HP
- ❑ 2 STROKE
- ❑ 9-1/16” Cylinder Bore
- ❑ 11” STROKE
- ❑ 710 Cubic Inch VOL.
- ❑ 16:1 COMP RATIO
- ❑ 1850 PSI PFP
- ❑ 904/954 8TH
- ❑ 269 RPM Idle

ALCO

- ❑ 2600/3100/3300 HP
- ❑ 4 STROKE
- ❑ 9”
- ❑ 10.5”
- ❑ 668
- ❑ 12.5:1/11.75:1
- ❑ 1750 PFP
- ❑ 1000/1050
- ❑ 350 RPM

GM EMD

- 17:77/17:90 Gear Ratio
- 8 Blades – 52” R/Fan
- AC-AC Traction System
- 123T/126T Loco. Wt.
- 20.5T/21T Axle Load
- Co-Co Axle configuration
- 43% Adhesion
- 53/55T TE
- 32% continuous all weather adhesion

ALCO

- 18:65/ 18:74
- 6 Blades
- DC-DC/AC-DC
- 112.8T/117T/123T
- 18.8T/19.5T/20.5T
- C0-Co Axle conf.
- 27%
- 31/36/41T
- Less

GM EMD

ALCO

- CCB Brake System
 - 6000 L Fuel capacity
 - 2.80 L/ 1000GTKms SFC
 - 30 Lakhs saving/loco/
Annum
 - 0.3 – 0.5 L/ 100 Kms LOC
 - 2.6 lakhs saving/ Loco
/Annum
 - 1EMD Loco= 1.5 WDG3A
Loco
- 28LAV1/IRAB1
 - 5000/6000 L
 - 3.25 Liter
 - 1-1.5 Liter / 100 Kms
 - 2 WDM2 Loco = 1
EMD Loco

GM EMD

ALCO

- 3.5 Man Power Per Loco
- 31 Lakhs Maintenance Cost
- 6th Notch TSC Gear Driven
- Turbo screen Provided
- Soak back System
- 02 Nos. A/Cooler
- 10 M/Bearing.

- 8.6
- 31 Lakhs Maintenance Cost
- Exhaust Driven
- Not provided
- One
- 9

GM EMD

ALCO

- 950/1457 L Sump capacity
- 4 LOP
- 121 –126degree C HOD
- 1035- 1050 OSTA Tripping RPM
- Main Lube Oil pump capacity- 229 GPM
- Piston Cooling Pump capacity- 109 GPM

- 910/1025/1270 L
- One
- ----
- 1150 -1220
- Lube Oil Pump Discharge- 640 GPM

GM EMD

- ❑ 6.5” Crank pin Dia.
- ❑ 8.50” Journal Dia.
- ❑ 3 Rocker Arm Assembly
- ❑ 4 Exhaust valve
- ❑ Air Box
- ❑ 1045 L Cooling System capacity
- ❑ 14 Cubic feet/ Box sand boxes capacity

ALCO

- ❑ 6”
- ❑ 8.5”
- ❑ 2
- ❑ 2 inlet & 2 exhaust
- ❑ V- gallery
- ❑ 1210 L
- ❑ 14 cubic feet / box sand Box capacity

GM EMD

- Sight Glass and Bypass Valve in Fuel Oil System
- Sight Glass at Engine mounted Filter
- EFCOS
- MUI/EUI
- Injector nozzle Break in Pr.- 1800-2300 PSI

ALCO

- NIL
- NIL
- NIL
- FIP Based
- 3600-3800/3900-4050 PSI

GM EMD

ALCO

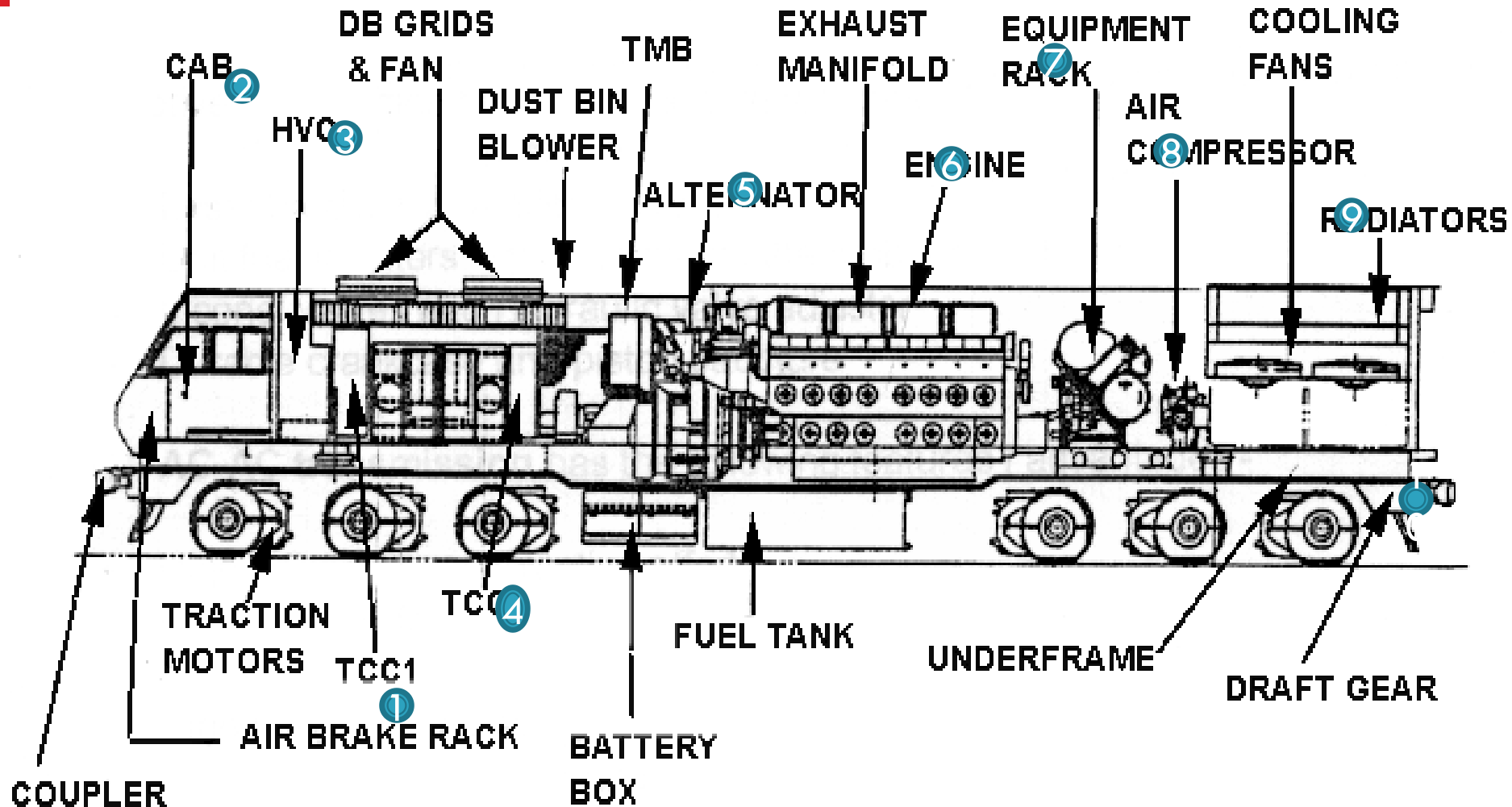
- Water Cooled Compressor
 - Cooling water flow at 200 /900 RPM= 4/15-25 GPM
 - Major O/h - 8 Years
 - Valve reconditioning interval- 4 years
 - Min. Lubricating Oil Pr.- 10 PSI at 200 RPM
 - Sump Capacity- 9.8 L
- Air Cooled
 - NIL
 - M4/M12/M24
 - 21/30 days/60 days
 - 20 PSI App.
 - 21 L ELGI R80101

GM EMD

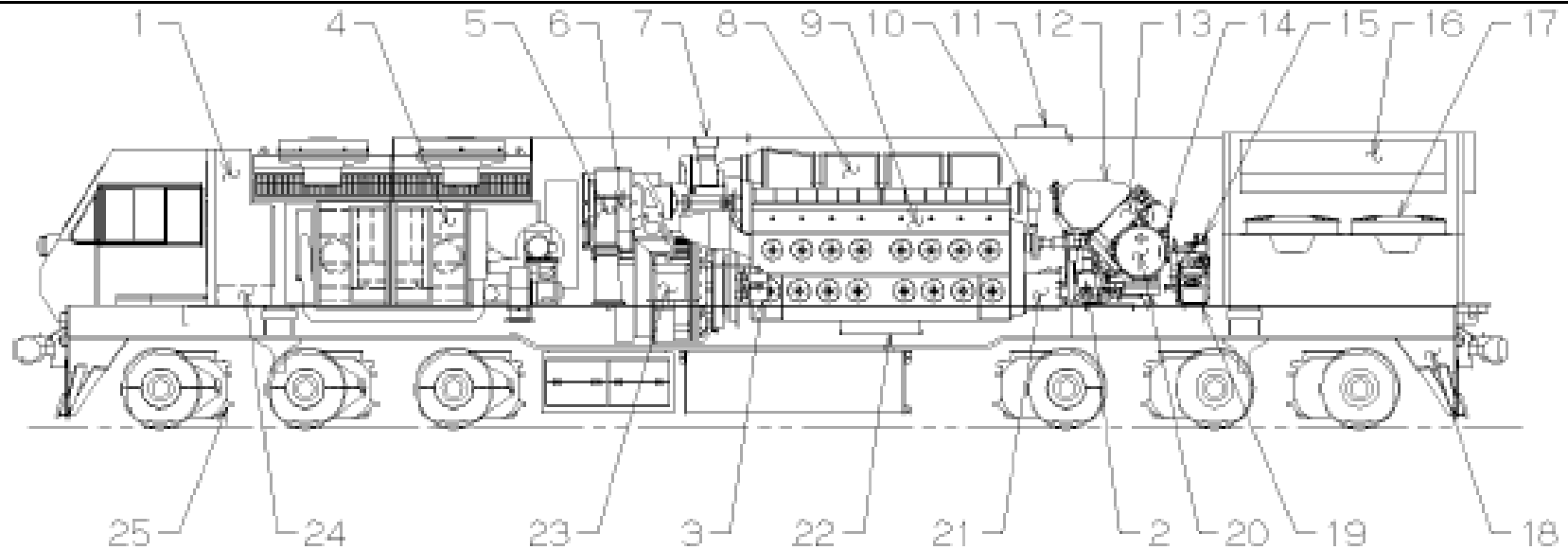
ALCO

- | | |
|-----------------------|--------|
| □ Idle- 200 RPM | □ 350 |
| □ Notch I- 269 | □ 400 |
| □ Notch II- 343 | □ 450 |
| □ Notch III- 490 | □ 550 |
| □ Notch IV- 568 | □ 650 |
| □ Notch V- 651 | □ 750 |
| □ Notch VI- 729 | □ 850 |
| □ Notch VII- 820 | □ 950 |
| □ Notch VIII- 904/954 | □ 1050 |

EMD LOCO LAYOUT



Front view of locomotive



G141358

- | | | |
|------------------------------------|-------------------------------------|---|
| 1. #1 Electrical Control Cabinet | 10. Governor | |
| 2. Fuel Pump | 11. Engineroom Vent | 19. Compressor Filter |
| 3. Engine Starting Motors (Qty. 2) | 12. Engine Water Tank | 20. Lube Oil Filter Tank |
| 4. Traction Control Cabinet | 13. Lube Oil Cooler | 21. Lube Oil Strainer |
| 5. Traction Motor Cooling Blower | 14. Primary Fuel Filter | 22. Lube Oil Sump |
| 6. Main Gen. Assembly Blower | 15. Air Compressor | 23. Main Generator Assembly |
| 7. Engine Exhaust Stack | 16. Radiators | 24. No.1 Elect. Cntrl. Cab't Air Filtr. |
| 8. Engine Exhaust Manifold | 17. AC Radiator Cool. Fans (Qty. 2) | 25. Traction Motors (Qty. 6) |
| 9. Diesel Engine | 18. Draft Gear | |

Various compartments

- ❑ Nose compartment
- ❑ Driver's cabin
- ❑ Electrical control cabinet(ECC-1 & 2)
- ❑ Traction control converters compartment(TCC)
- ❑ Traction generator compartment
- ❑ Engine compartment
- ❑ Engine accessories compartment
- ❑ Compressor compartment
- ❑ Radiator compartment
- ❑ Superstructure of locomotive.

1.Nose compartment

- All valves related to Brake system (CCB) are fitted.
 - Display unit ,
 - PSU,
 - Dead engine cock etc.
- Sanding magnet valve and Magnet valve for short hood horn is also provide inside this compartment and this may be seen after opening of side cover near by the driver cabin on right side.

2.Driver cabin

- 02 Nos -Control stand.Each control stand mainly consists –
 - Various gauges
 - Reverser handle,Throttle with dynamic brake,Auto brake V/V handle
 - VCD reset button
 - Sanding switch
 - Horn switch (for L.H side & S.H side)
 - Wiper knob.



3. Electrical Control Cabinet

- ECC-1 situated on the back wall of the loco cab. It controls and powers the loco & it consists-
 - (Engine Control Panel).
 - EM2000 (Display screen).
 - Circuit Breaker Panel
 - Circuit breaker & test Panel.



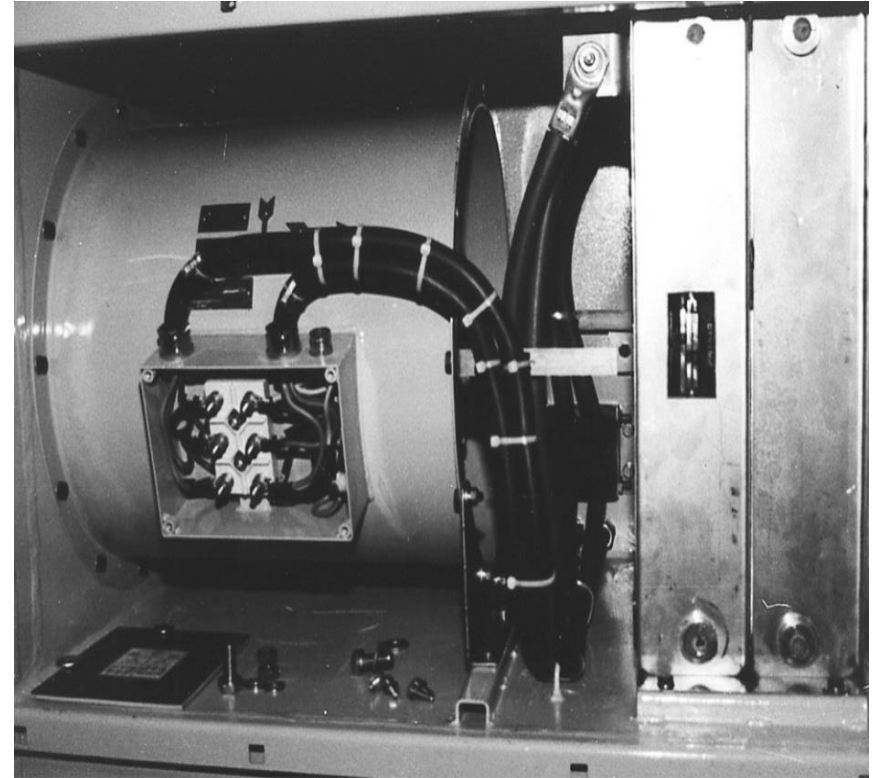
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ECC-2

- ECC-2 is mounted on the left side of the locomotive, under the loco under frame, between the Fuel tank and the No.2 bogie.
 - AUX GEN circuit breaker mounts in this cabinet.

4. TCC compartment

- It consists of –
 - TCC1 (for each parallel set of 3 Nos Tr.Motors)
 - TCC2 („)
 - TCC electronic blowers (2 Nos) for TCC1&TCC2.
 - Dynamic braking grids(8 Nos grids ,4 Nos on each side)
 - Dynamic grid cooling fans (2Nos).
 - Blower for inertial filters (Dust bins blowers).



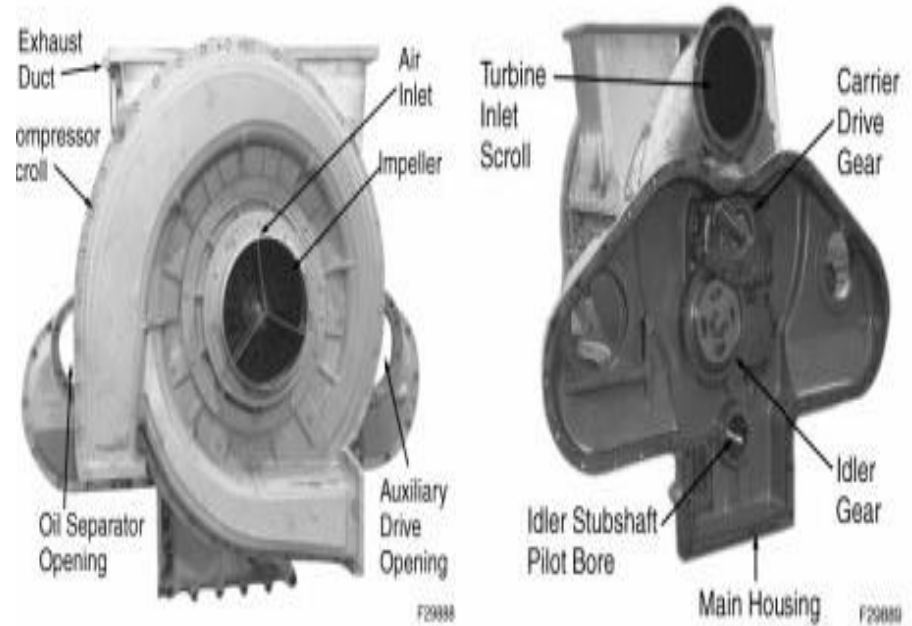
F43653

5. Generator compartment

- it consists of following components –
 - Two Alternator(01No-Main Alternator & 01No-Companion Alternator).
 - Traction motor blower.
 - TSC with after cooler.
 - Auxiliary Generator.
 - Engine Starting motor-2 Nos
 - Inertial air inlet filters for engine left /right air intake and for TM blower.

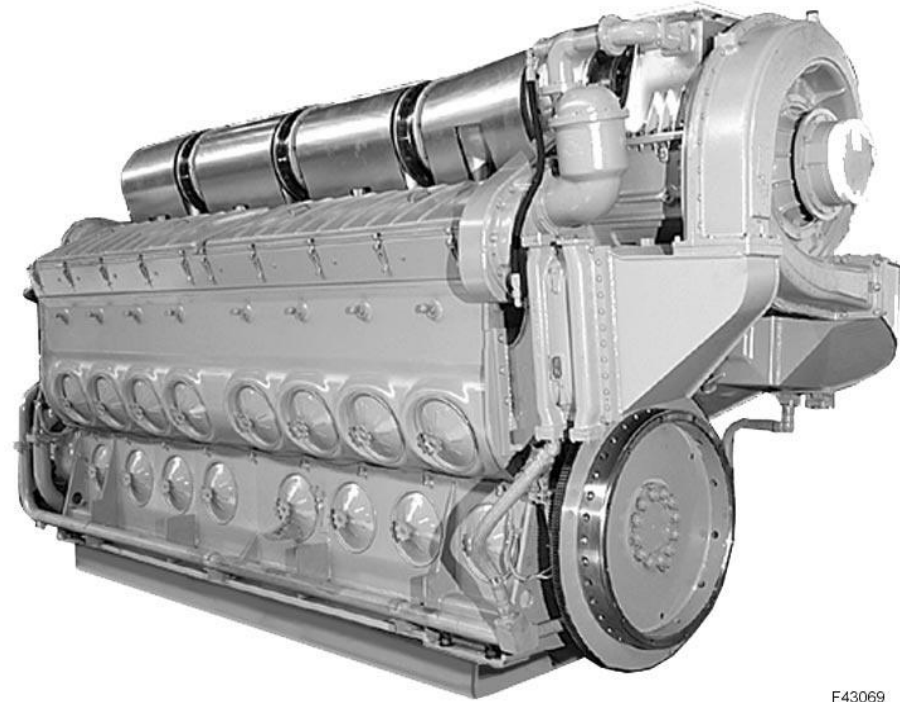
Turbo supercharger

- Engine driven till 6th notch.
- Gear ratio 1: 16.7
- Engine driven necessary for engine starting, light load operation, and rapid acceleration.
- Switch over to exhaust gas drive from 6th notch onwards
- Turbo screen provided.
- Soak back lubrication system for pre and post lubrication.



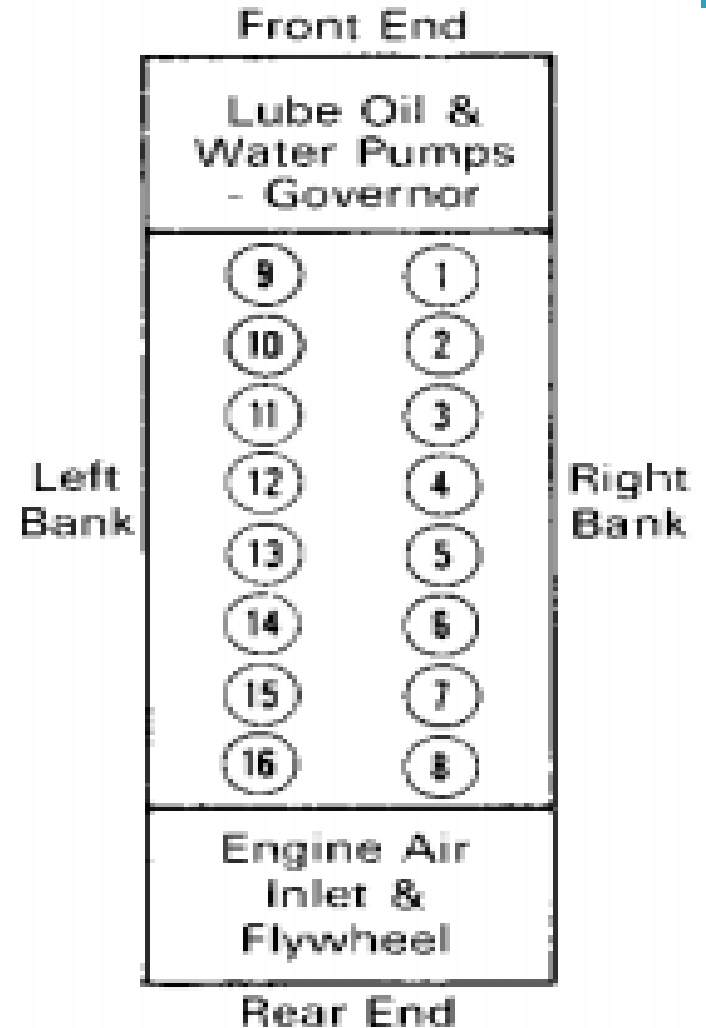
6.Engine compartment

- Engine model : 710 G3B
- Crank Shaft Rotation : Anti-clockwise (facing fly wheel end)
- Max. Engine RPM(Full Speed) : 904-954 (8th notch)
- Idle RPM(Speed) : 200
- No of Cylinder : 16
- Compression Ratio: 16:1
- Engine Governor: WW Governor



Engine arrangement

- Governor, water p/p, and the lube oil p/p are on the “front” of the engine.
- The turbocharger and the flywheel are located at the coupling end or “rear” of the engine.



Crankcase assembly



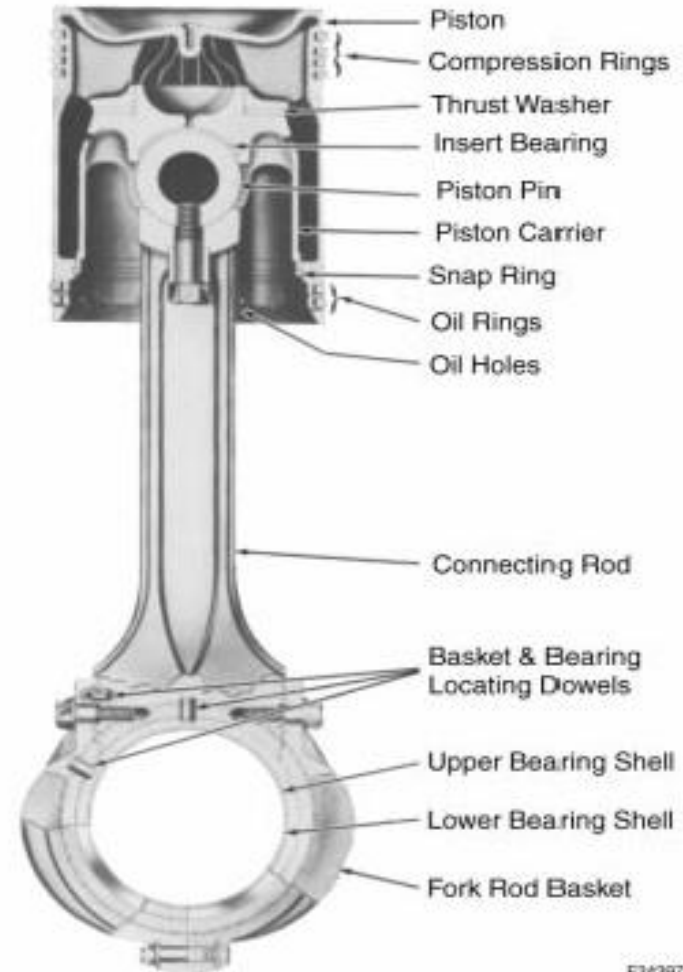
Power assembly

- Power assembly (consisting of con.rod, piston, liner and cylinder head in assembled form as single unit).
- Unit replacement facility.
- Easy to replace.
- Valve seat insert not used in Cylinder head.
- Reduces failure due to droppage of valve seat insert.



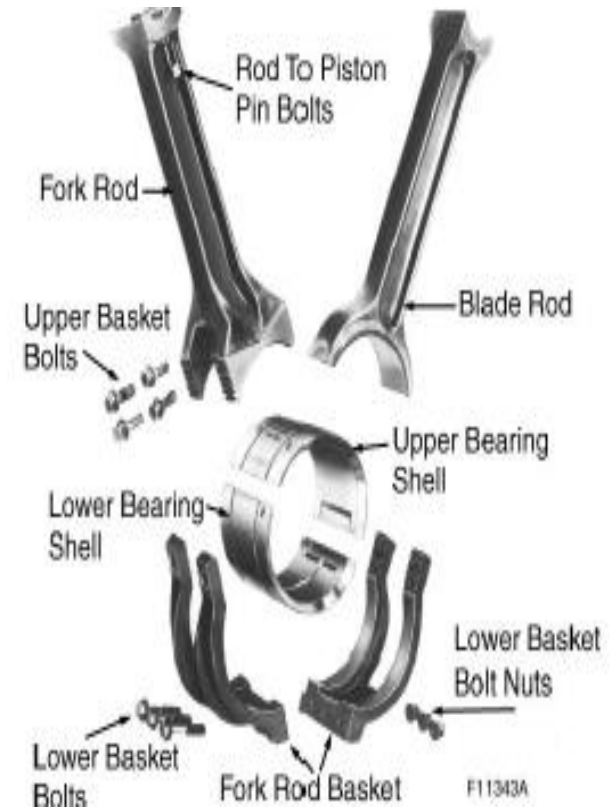
Liner and piston

- Cast Iron Liner with Laser hardened bore
- Fully floating cast iron alloy Piston with tin plating.
 - Piston carrier.
 - Maintain uniform clearance.
 - Cooling of the piston crown with a pressurized oil.
 - Half set of bearing used on the top side of piston pin.



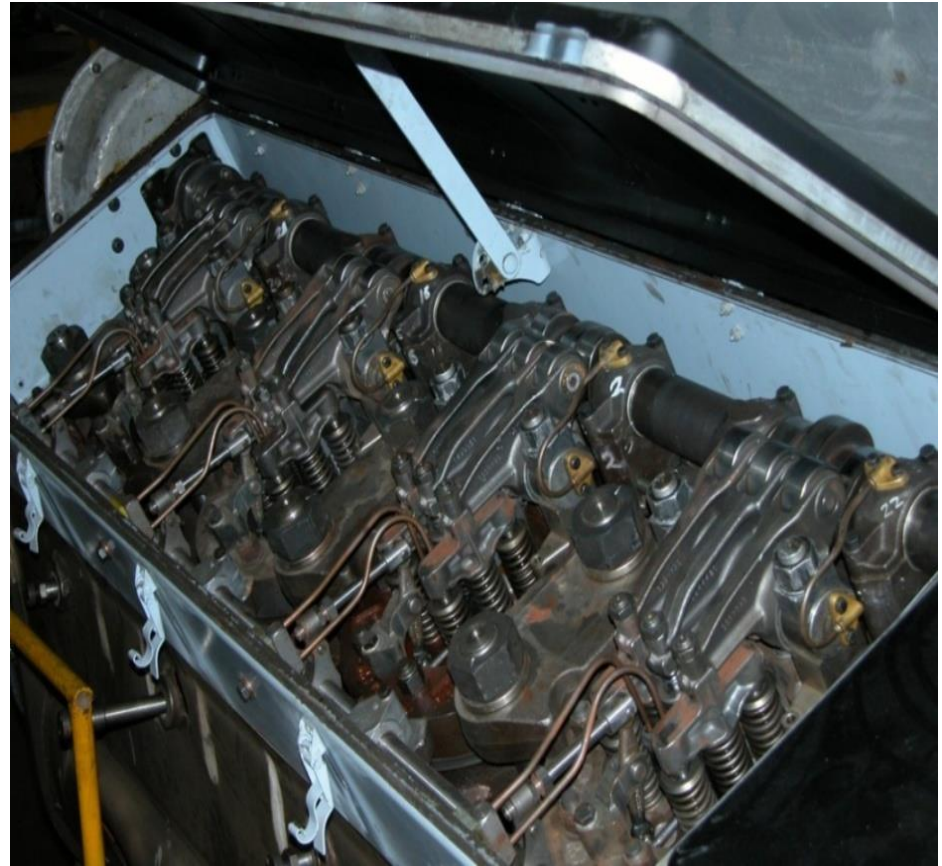
Connecting Rod

- Interlocking Con. Rod. Design.
 - consisting of blade rod and fork rod.
 - No Offsetting of left and right bank cylinders.
 - Reduced length of crankcase and crankshaft
- Same set of bearing is used for both the rods.
 - Load on bearing reduced due to increased area, long life bearing.



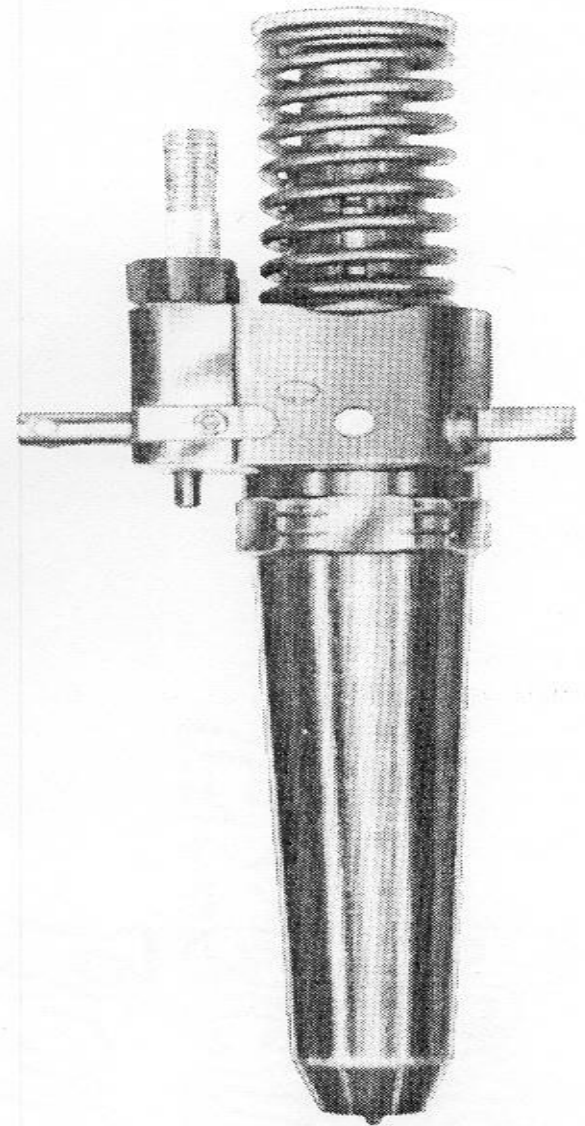
Rocker assembly & Valve bridge

- Overhead camshaft operates the valves directly through Rocker assembly.
 - No push rod is required.
- Two Valve Bridge with automatic lash adjuster (hydraulic) operate 4 nos. of exhaust valves.
 - No clearance is required to be maintained between valve stem and valve bridge.



Unit Injector

- Unit Injector (combined Pump and Nozzle assembly).
 - ▣ H.P. line not required
- Injection pressure can be increased upto 20000 to 30000 psi, helps in better atomisation, mixing and combustion
 - ▣ More accurate timing.
 - ▣ Improves SFC.



Ejector Tube

- ❑ Crank case vacuum is maintained through Ejector tube extended to turbo chimney (Vacuum created by ventury effect).
- ❑ Crank case exhaustor motor is not required.
- ❑ Simple, trouble free and economic.



7.Engine Accessories Compt.

- It consists of –
 - wood ward governor
 - Lube oil pumps
 - Water pump (2 Nos)(gear driven)
 - Lube oil strainer.
 - Lube oil cooler
 - Pressurized water tank
 - Fuel primary filter
 - Fuel pump with motor
 - Engine mounted fuel oil secondary filter(2 Nos) with sight glasses.
 - EPD



Water Expansion Tank

- Raise the boiling point of the cooling water. This in turn permits higher engine operating temperatures, with a minimal loss of coolant due to boiling.
- Pressurization also ensures a uniform water flow.
- It minimizes the possibility of water pump cavitations.
- No losses of water during vaporization.



1. Filler/Relief Valve Handle (Pull Down To Open)
2. Pressure Cap
3. Filler Pipe Connector

Engine Protection Device(EPD)

- These devices or sensor inputs are designed to shut down the engine in the event of a malfunction occurring during engine operation.
 - Low oil pressure shutdown plunger(Governor).
 - Low water and Crankcase pressure detector assembly (Governor)
 - Mechanical Over speed Trip.
 - Hot oil temperature (Governor)
 - Low fuel oil pressure knock down

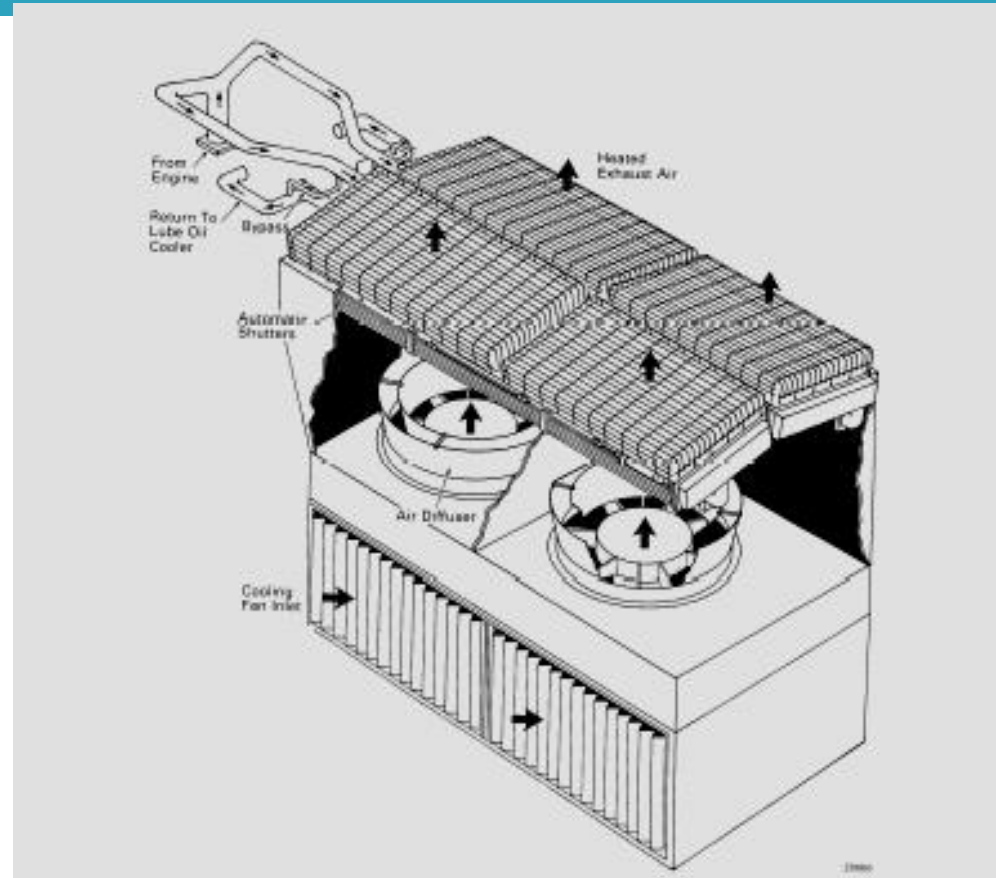
8. Compressor Compartment

- This compartment consists of –
 - 01 No-2 stage ,3 cylinder, water cooled Air compressor.
 - Working pressure- 9.84 Kg/cm²
 - Rotates at engine speed.
 - Computer controlled pneumatically operated compressor clutch .



9. Radiator compartment

- it consists of-
 - 02 Nos Radiator core located above the cooling fans.
 - Two Radiator cooling fans (AC motor driven)
 - Get power from Companion Alternator.
 - Main reservoir air cooling coils.



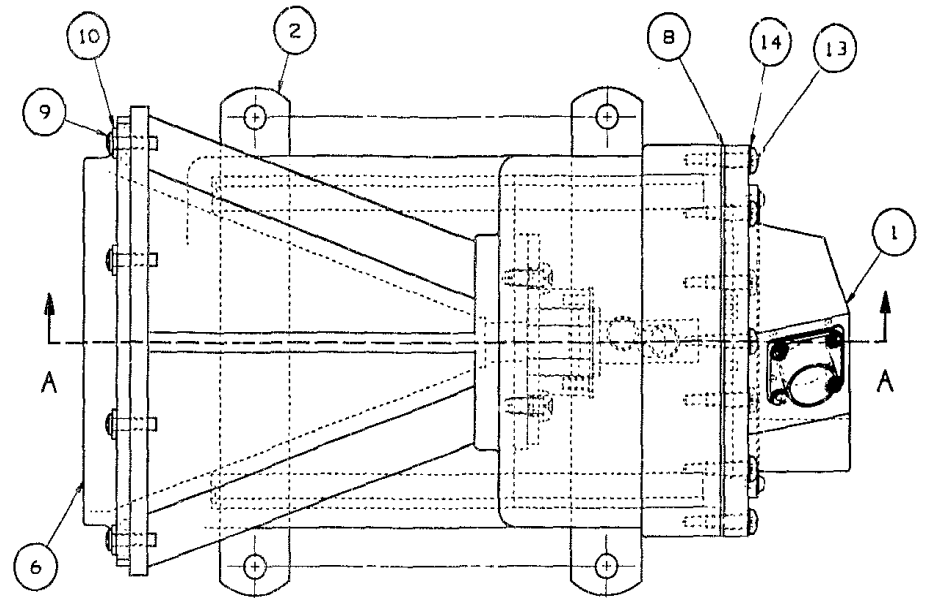
10. Superstructure of Loco

- Fuel tank, Cap-6000 ltrs (WDG4, WDP4)
- 02Nos Main reservoir on left side of loco.
- Air dryer Rt side of the loco.
- 8 nos sand boxes on wheel pairs 1,3,4,&6,.
- BP&FP angular cut off cocks are provided at both ends of the loco.

Radar

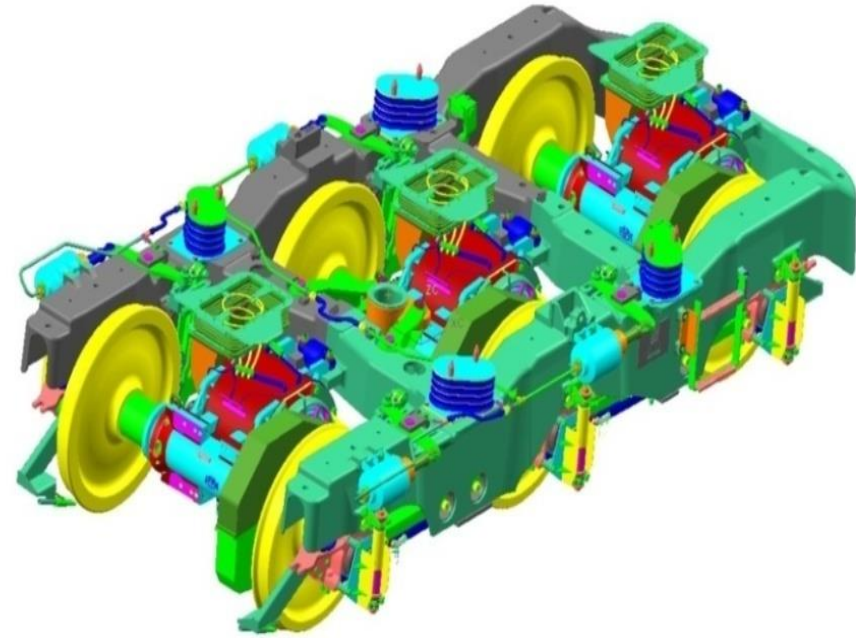
□ It senses the locomotive speed w.r.t ground and sends the speed signal to the speedometer in the driver cab.

- In WDG4, located between front bogie & fuel tank .
- In WDP4, located between fuel tank & rear bogie.



Bogie

- ❑ HTSC(High tensile steel cast).
- ❑ Two-stage suspension.
- ❑ Centre pivot does not take any vertical load and is used only for transfer of traction and braking forces.
- ❑ All Traction motor nose positions are oriented to the same side of each axle within the bogie frame.
- ❑ Axle boxes are fitted with tapered roller bearings.
- ❑ Six vertical hydraulic dampers.
- ❑ Two hydraulic yaw dampers .
 - The yaw dampers are oriented in such a way that they provide damping both in lateral and yaw modes.





Thanking you