WDG4
Charge Air Sysytem

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GM / EMD LOCOMOTIVE

Flow of Presentation

- Need for supercharging
- Methods of supercharging
- Why, What and How of a Turbocharger
- Basic information about 710G series turbochargers
- Component details
- Process of Charge Air System

Need for supercharging

2-stroke engine :–

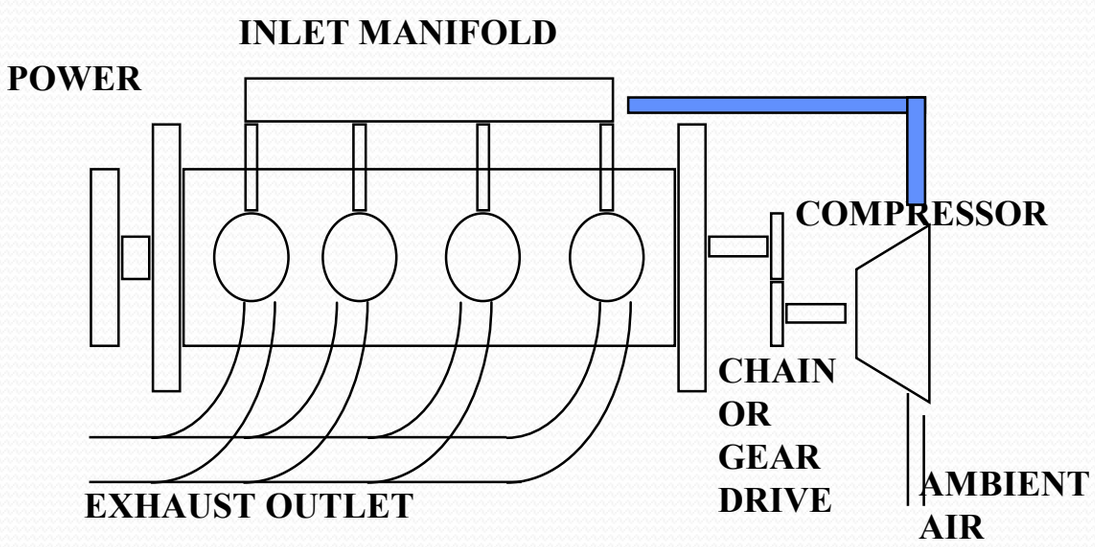
- introduction of air at a density higher than the ambient and proportional increase in the amount of fuel that can be burned.
- With out increasing Engine size getting more Horse Power.
- For better scavenging.

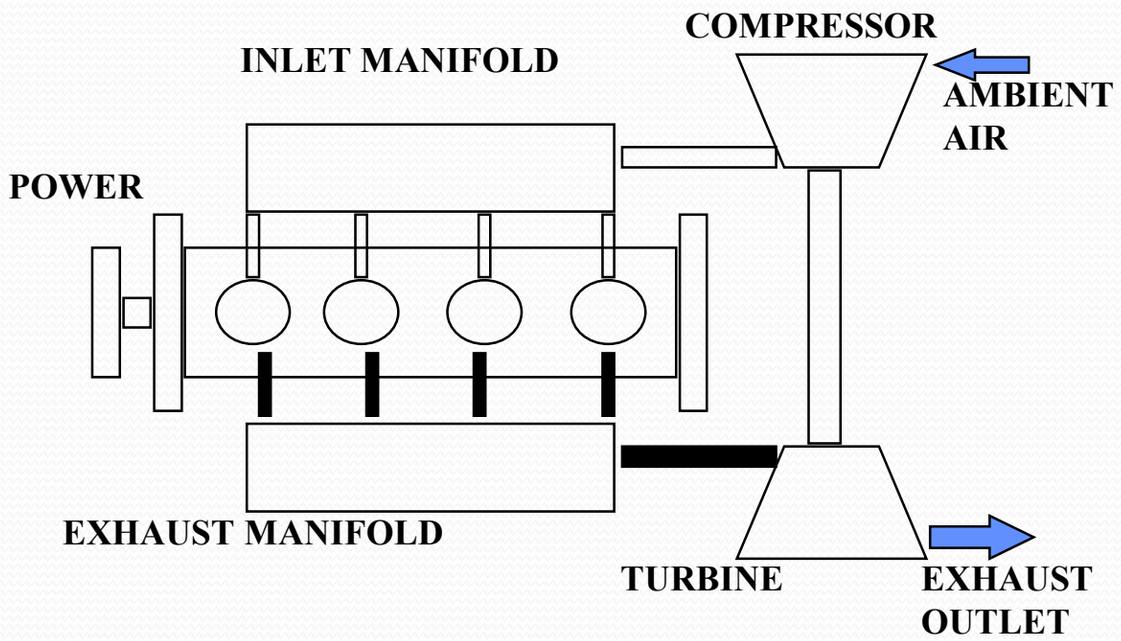
SUPERCHARGING

- IT CAN BE DEFINED AS THE INTRODUCTION OF AIR(OR AIR/FUEL MIXTURE) INTO ENGINE CYLINDER AT A DENSITY GREATER THAN AMBIENT.
- BENEFIT--
  - ALLOWS A PROPORTIONAL INCREASE IN FUEL THAT CAN BE BURNED & HENCE RAISES THE POTENTIAL POWER OUTPUT
  - EFFICIENCY MAY ALSO INCREASE

Methods of Supercharging

- Mechanically or otherwise driven compressor
- Turbocharger





Why turbochargers?

- Uses the energy of waste hot exhaust gas of the engine to drive the compressor.

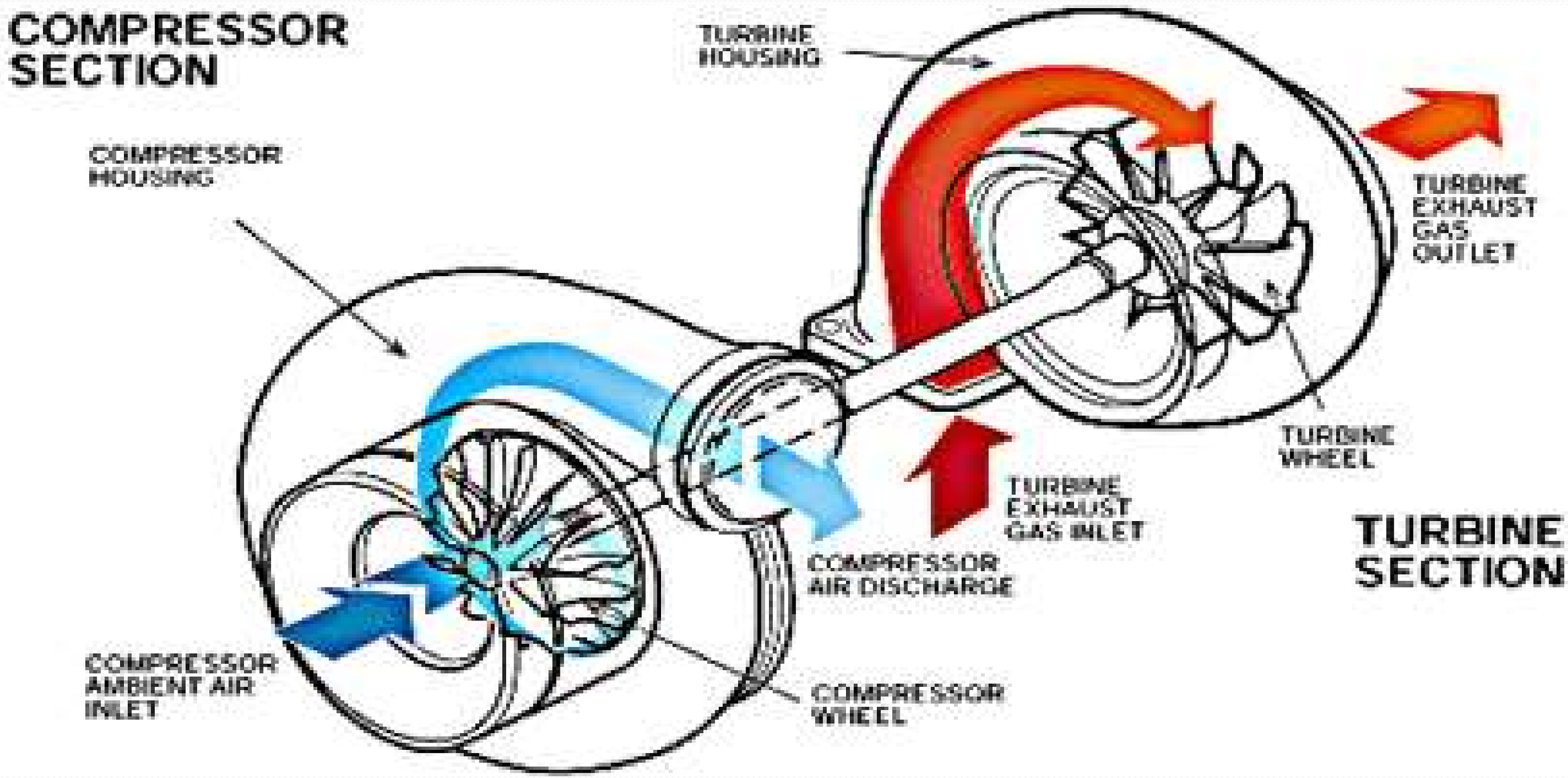
WHAT IS A TURBOCHARGER

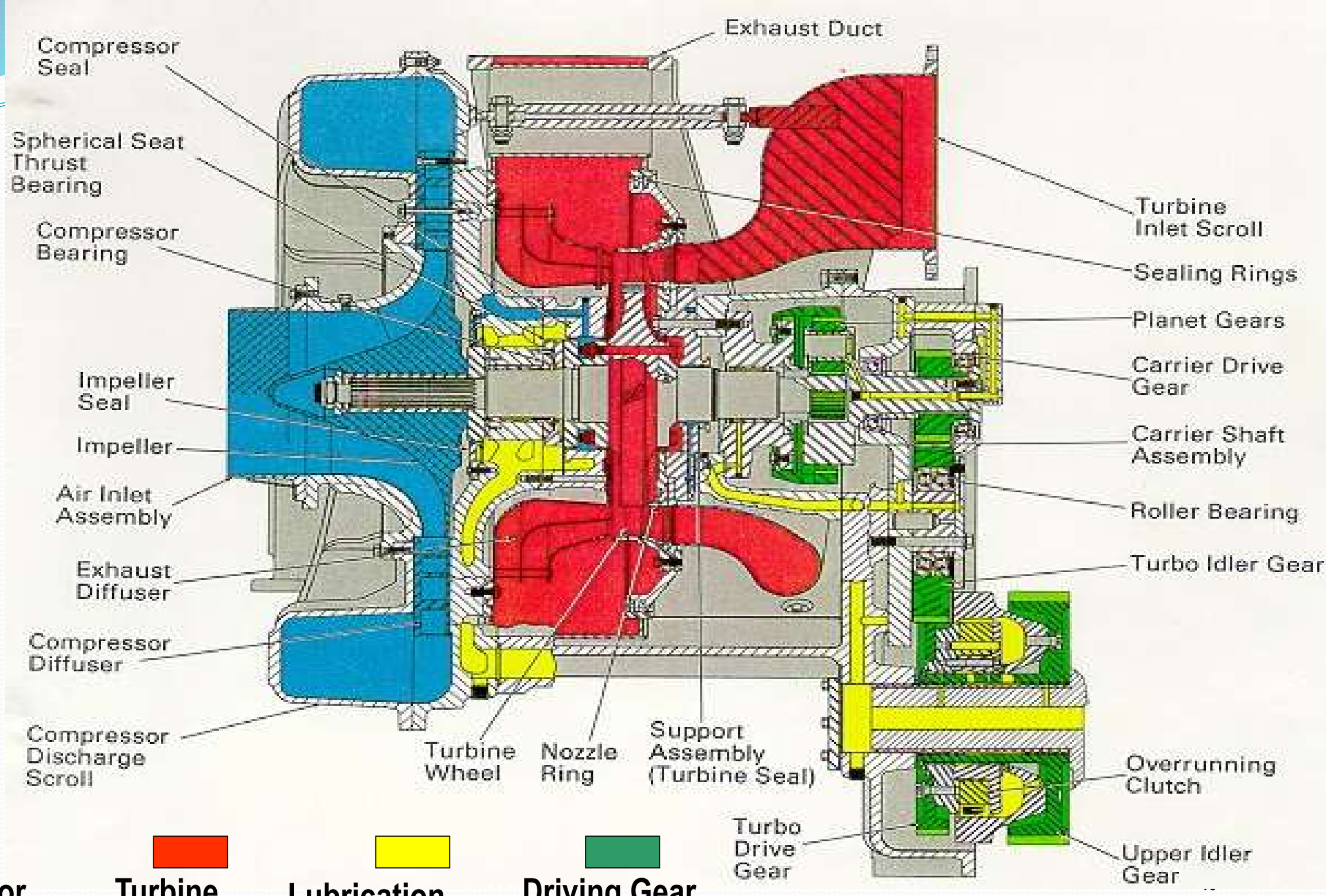
- TURBOCHARGER BASICALLY CONSISTS OF A COMPRESSOR AND A TURBINE COUPLED ON A COMMON SHAFT.
- THE COMBINATION OF A SINGLE STAGE CENTRIFUGAL COMPRESSOR AND
- A SINGLE-STAGE AXIAL FLOW TURBINE OR
- A RADIAL FLOW TURBINE

ARE THE MOST COMMON TURBOCHARGERS.

HHP TURBOCHARGER HAS SINGLE STAGE CENTRIFUGAL COMPRESSOR AND SINGLE STAGE AXIAL FLOW TYPE TURBINE.

Schematic of a Turbocharger





Compressor Section

Turbine Section

Lubrication

Driving Gear Train

Basic information about HHP turbocharger

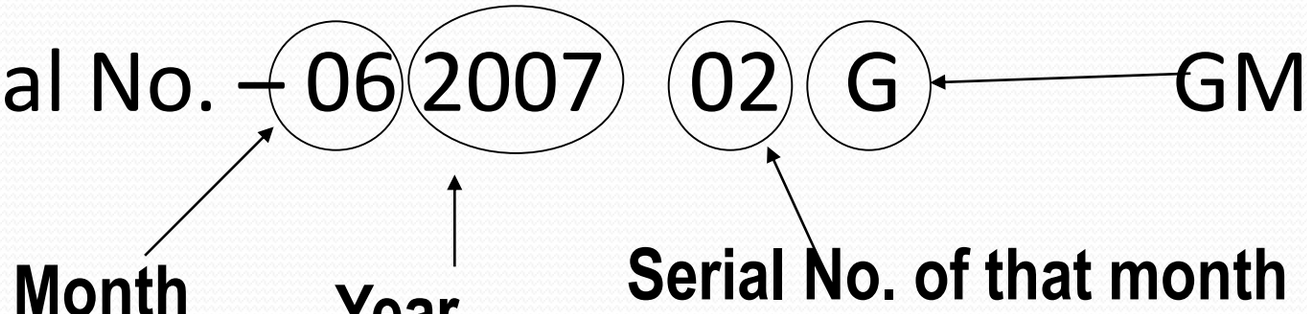
- No. per engine – 1
- No. of stages – 1
- Drive–Mechanically driven (gear drive) as well as exhaust gas driven (turbine) with an over- running clutch
- Rated output – 6.5 kg/sec
- Pressure ratio (Compressor) – 2.8
- Charge air Temp. (after compression) 171^{o}C
- Speed of Turbo (at rated output) – 18,950 rpm

Basic information about HHP turbocharger

- Lubrication – Engine lube oil
- Compressor – Single stage, centrifugal type
- Turbine – Single stage, axial flow type
- Critical Temperatures:
  - Compressor Stage – Air temp. upto 190.6^{o}C
  - Turbine Stage:
    - Inlet Gas Temp. upto – 593.3^{o}C
    - Outlet Gas Temp. upto – 482.2^{o}C

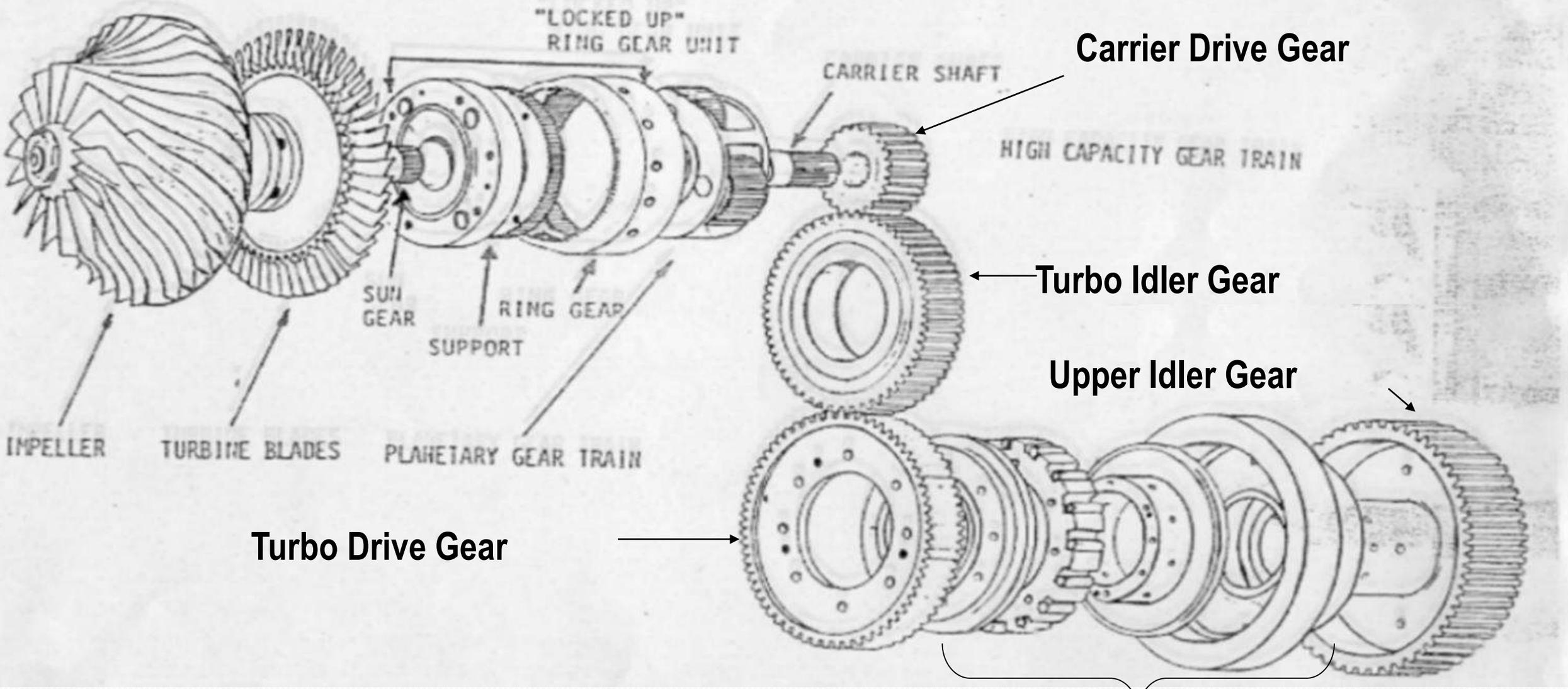
Identification of EMD Turbo

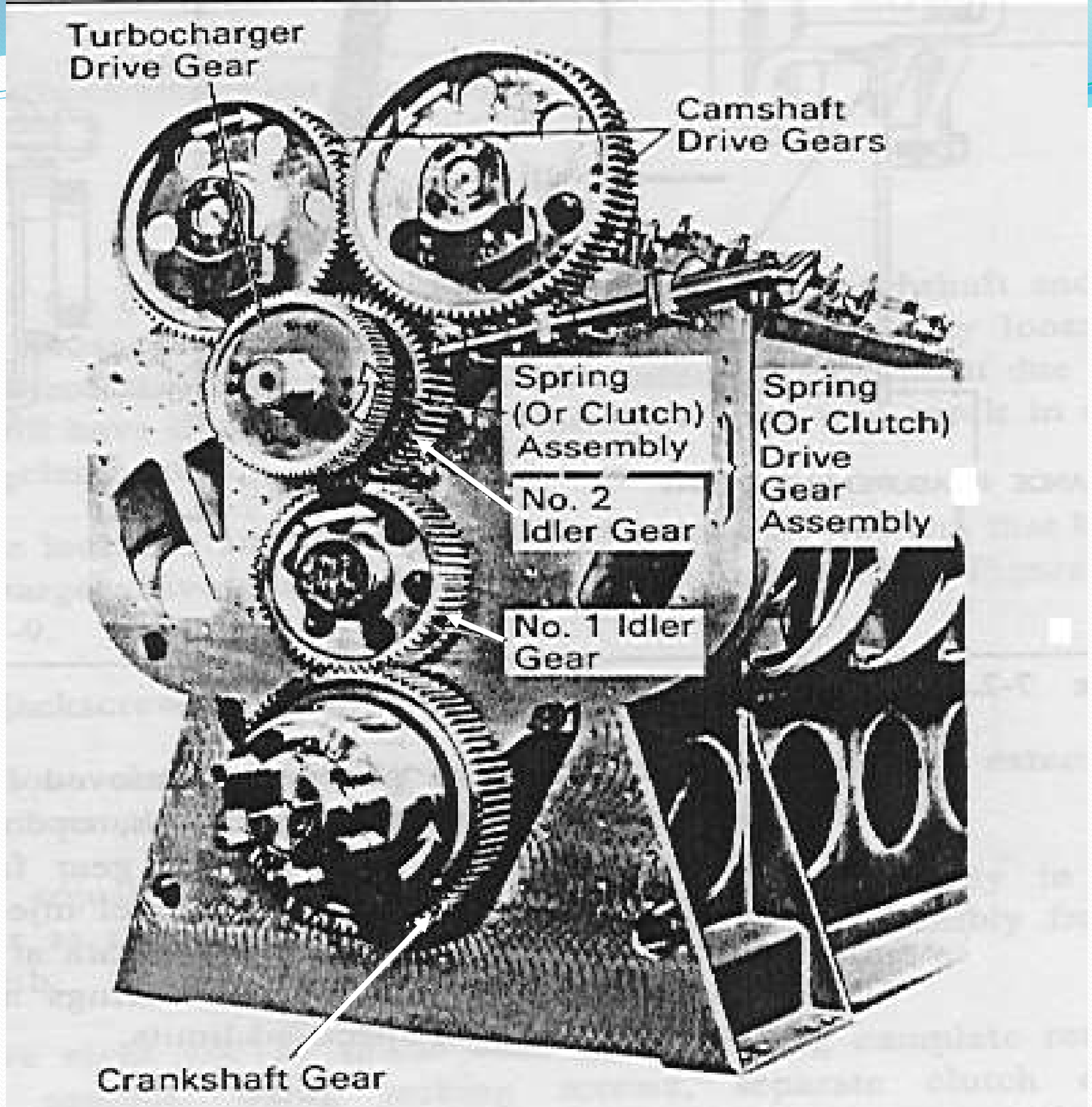
- Model No. – 710-16G
- Serial No. – 06 2007 02 G ← GM



Turbo Charger

- The turbo charger used here is a single stage turbine with a connecting mechanical gear train also through a overriding clutch.
- The connecting gear train is necessary for engine starting, light load operation and rapid acceleration.
- Initially, it is insufficient exhaust heat energy to drive the turbine fast enough to supply the necessary air for combustion.
- Primarily the Turbocharger driven by connecting gear train at Rear end.
- Drive by solely Exhaust gases when approaches 538^0c (Generally After 6^{th} or 7^{th} notch).


"LOCKED UP"
RING GEAR UNIT
CARRIER SHAFT
Carrier Drive Gear
HIGH CAPACITY GEAR TRAIN
Turbo Idler Gear
SUN
GEAR
RING GEAR
SUPPORT
Upper Idler Gear
IMPELLER
TURBINE BLADES
PLANETARY GEAR TRAIN
Turbo Drive Gear
External Clutch Assembly


Turbocharger
Drive Gear
Camshaft
Drive Gears
Spring
(Or Clutch)
Assembly
Spring
(Or Clutch)
Drive
Gear
Assembly
No. 2
Idler Gear
No. 1 Idler
Gear
Crankshaft Gear

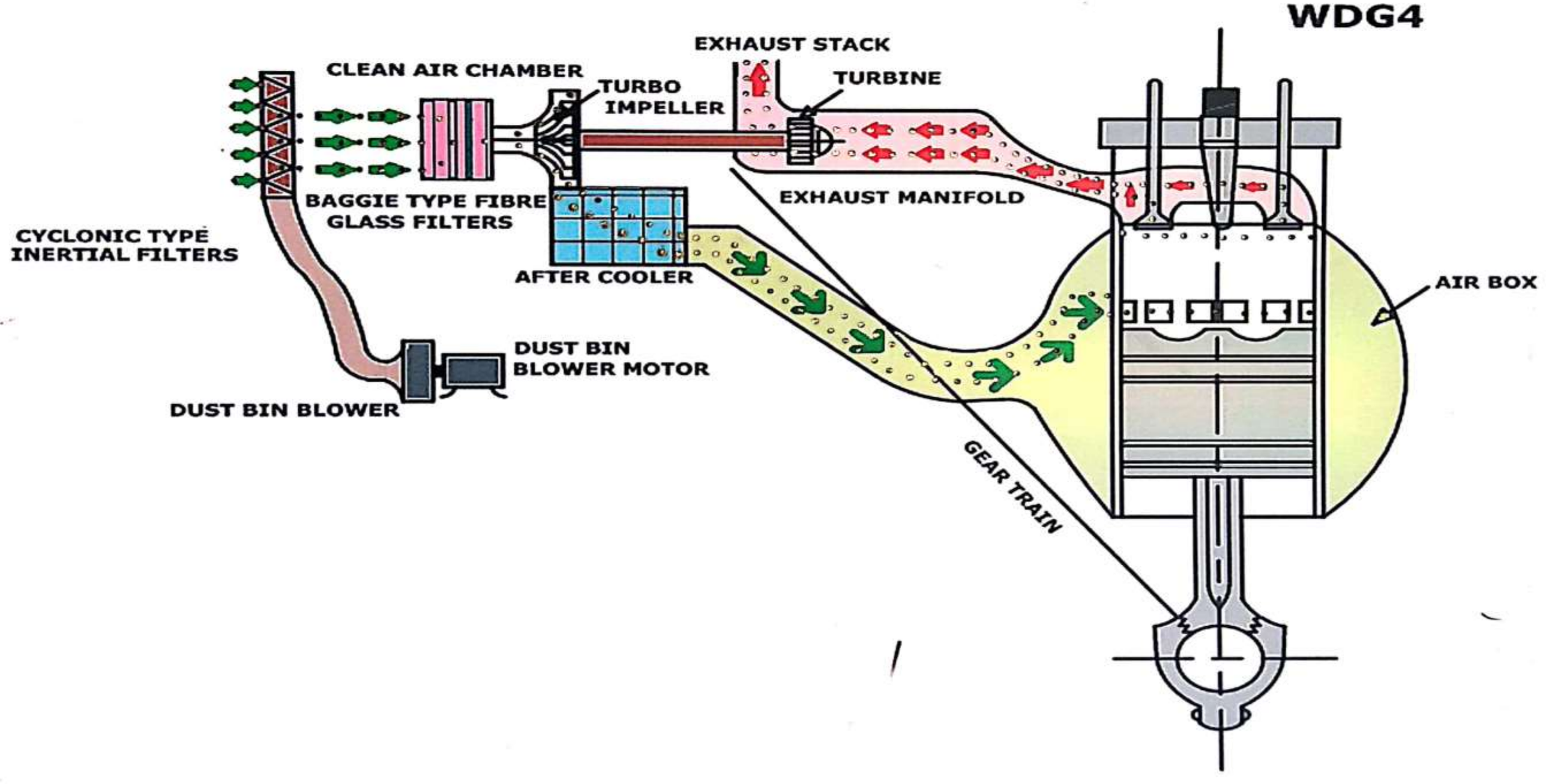
Air intake system

- Engine Air intake system takes care of the amount of oxygen required for complete combustion of fuel injected in the cylinders in various operating conditions.

- Diesel Engine in WDG4/WDP4 locomotive is a two stroke engine. Since the locomotive is provided with two-stroke engine, the inlet air requirement for proper combustion of the fuel is high.

- In order to supply the required quantity of air for complete combustion of injected fuel, this loco is provided with a turbo charger.

AIR INTAKE SYSTEM OF GT46 MAC LOCO



PROCESS OF CHARGE AIR SYSTEM

- 1. Inertial Air Intake/ Cyclonic type air intake filters.
- 2. Clean air chamber.
- 3. Baggy type engine air intake secondary filters.
- 4. Turbo super charger.
- After Coolers
- 5. Air Boxes.

Cyclonic Filters

- Two inertial air filter panels provided on either side of the locomotive at out side of the Clean Air Chamber (Central Air compartment). It is between TCC2 and Generator compartment.

- Which are made up of a series of tubes designed to produce cyclonic action. Its allow the ambient air with cyclonic motion in to the Clean air chamber.

- When the Engine is started, the Turbo impeller creates the suction at Central Air compartment .

Cyclonic Filters

- Which draws outside air rapidly through the inertial tubes with cyclonic motion.

- That dirt and dust particles present in the air which are heavier than air is thrown to the outer wall of the tube as the turbulence and dropped down.

- Further, these captured particles are sent out through the dust bin blower motor to the bottom of the locomotive and then the air became clean air.

Central Air compartment

The clean air is used for

- i. Combustion air for diesel engine.
- ii. Cooling air for Main Generator and Companion Alternator.
- iii. Cooling air for Traction Motors.
- iv. Cooling air for Traction inverter equipment.
- v. Pressurization of electrical cabinets.
- vi. Air for Air compressor.

Baggy Type Filters

- Air from Clean Air Chamber is drawn by Turbo through engine mounted baggy type filters.
- In baggy type filters the air is finely (2nd stage) filtered here.

Turbo Charger

- Fine filtered air is Compressed by Turbo impeller and is directed to after coolers through diffuser casing.
- Charge Air temp. after compression is 171^{o} c
- Critical temp. of Charge air after compression is 190.6^{o}c

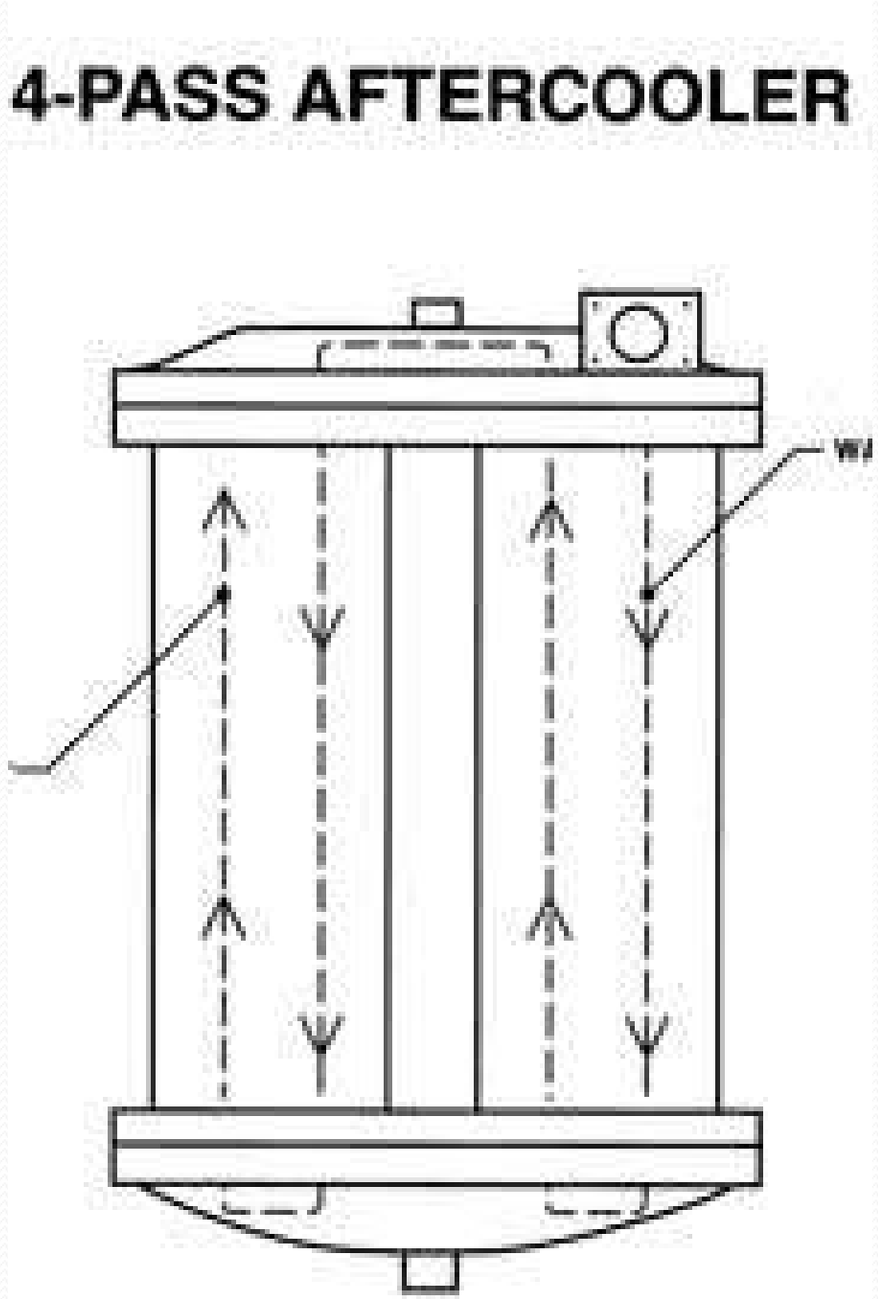
After Cooler

- Two After cooler are provided in this Locomotive, one on either bank of Engine.
- After cooler is “water – cooled” type to take out heat from the compressed air to supply high dense air for combustion of fuel.
- The water for After cooler is taken from the Engine Cooling water system.
- The high dense air is fed to Air Boxes.

After Cooler

- 2 Nos. after cooler are assembled along with the turbocharger.

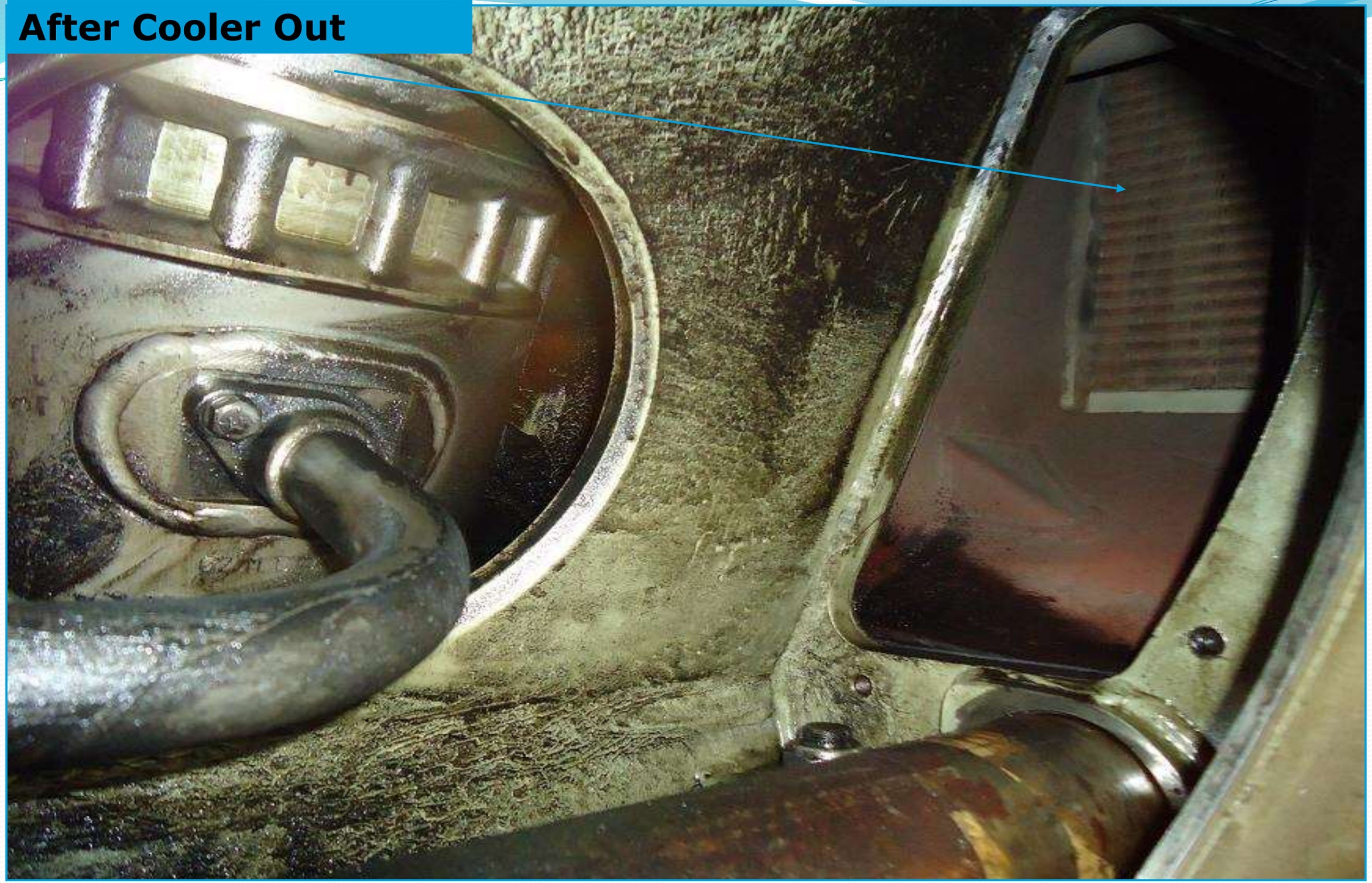
- It is used for bringing down the temperature of compressed air received from turbocharger

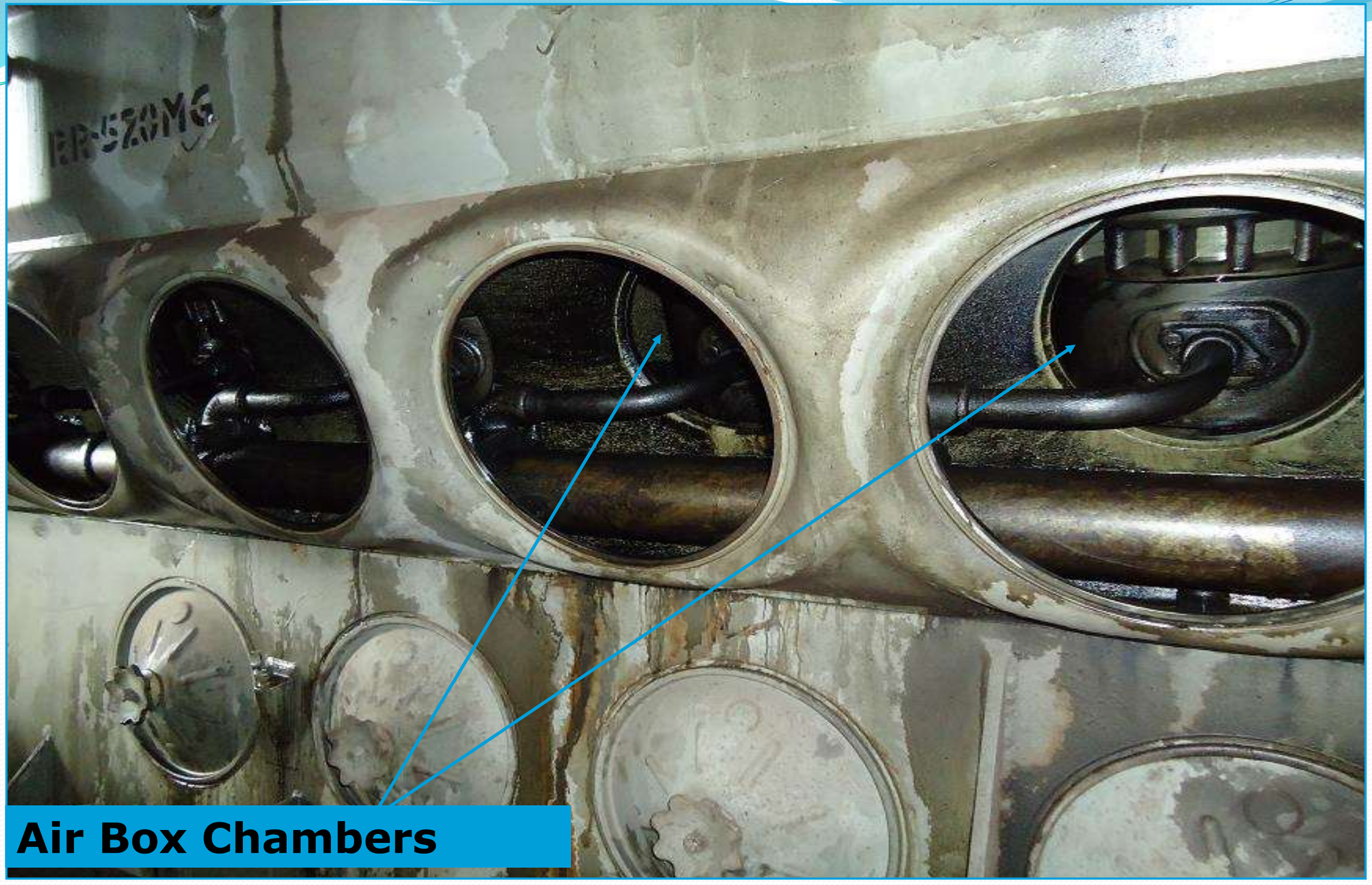


Air Boxes

- Air Boxes are provided on either side of Engine to supply the high dense air to combustion chamber.
- Air from the Air boxes is taken into individual cylinder, through Cylinder Liner port opening during suction stroke, when Piston uncovers the inlet ports.
- This pressurized air rushes into cylinders through 18 air inlet ports provided on each cylinder according to the engine timing.
- The huge air boxes on either side of the Engine to cool cylinders continuously, since the compressed and after cooled air is surrounded it.

After Cooler Out




Air Box Chambers

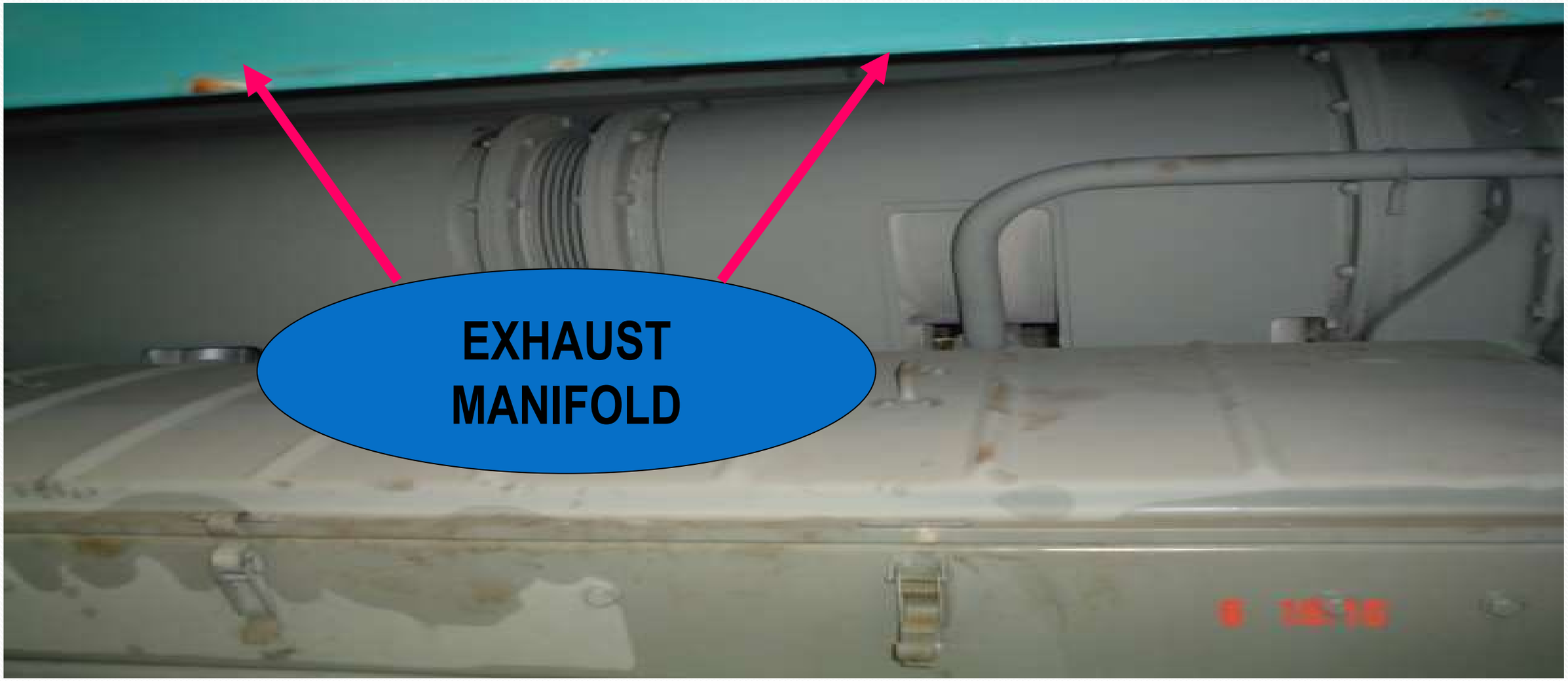
Exhaust Manifold

- After burning of the air + fuel inside the combustion chamber, the exhaust smoke of all cylinders are collected in exhaust manifold, during exhaust stork.

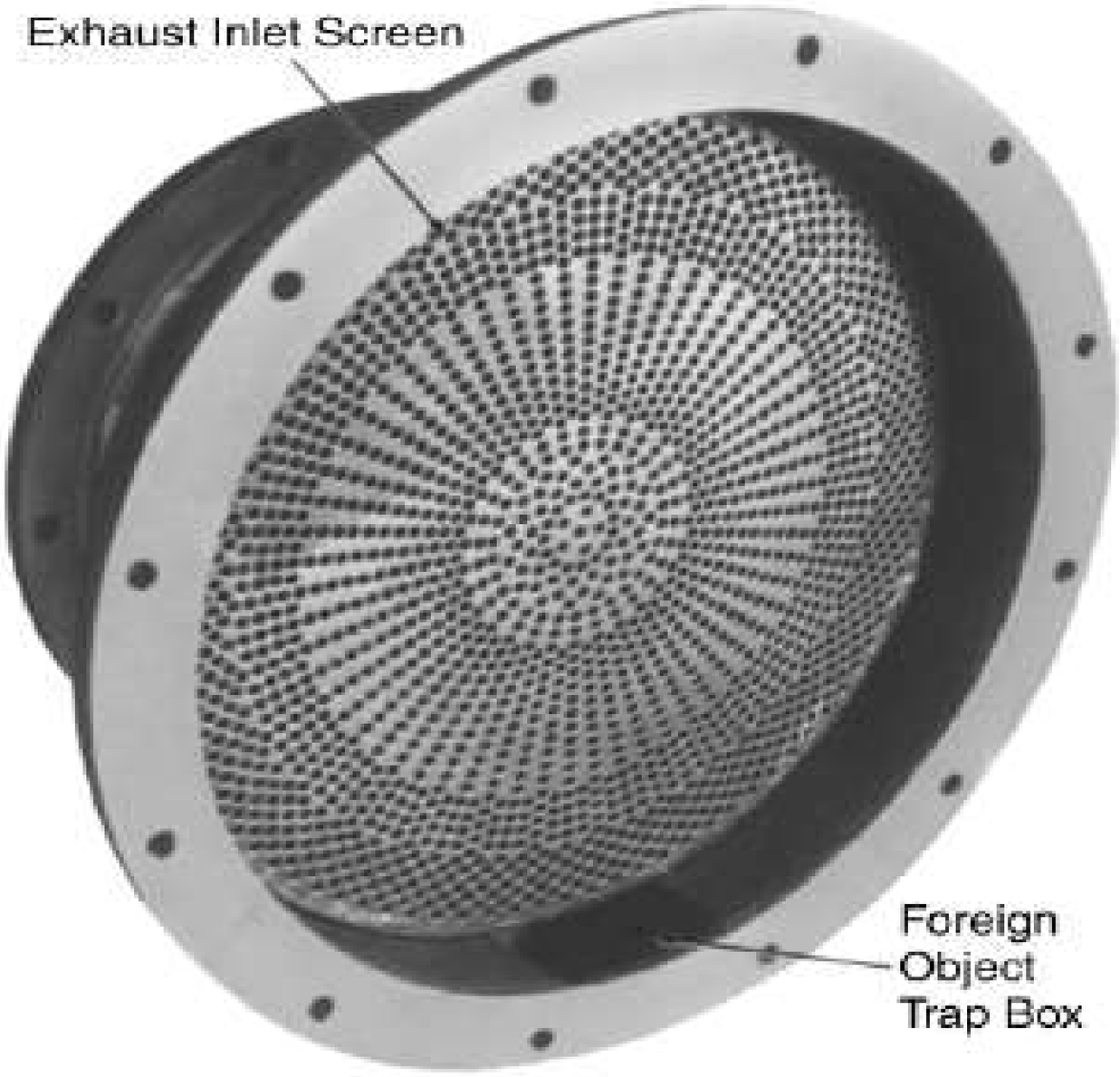
- The exhaust gases send to the turbine, through exhaust inlet screen.

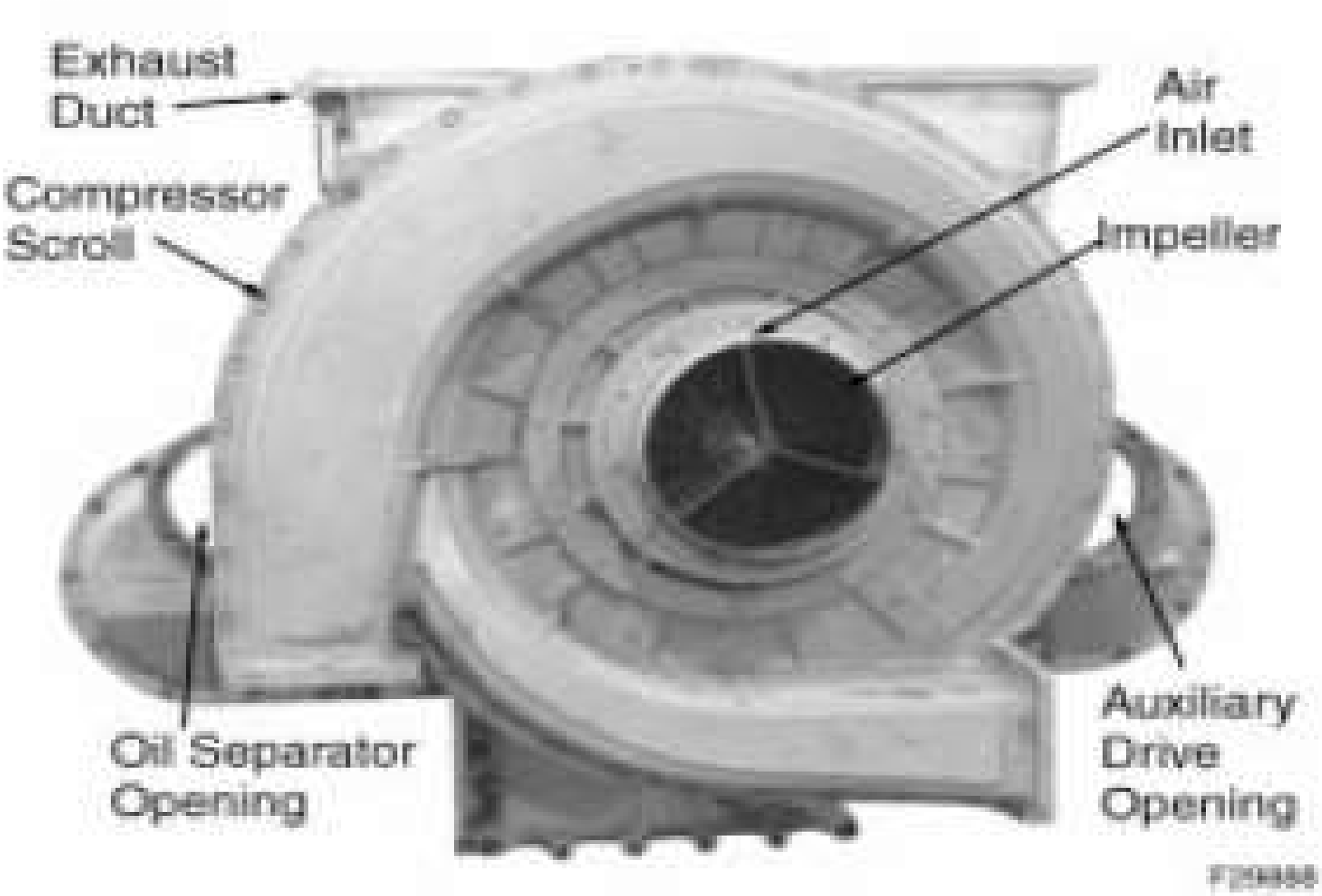
- Exhaust inlet screen filtered the exhaust smoke from foreign bodies.

Exhaust Manifold



Exhaust to Turbo


Exhaust Inlet Screen
Foreign
Object
Trap Box


Exhaust
Duct
Compressor
Scroll
Air
Inlet
Impeller
Oil Separator
Opening
Auxiliary
Drive
Opening

AIR INTAKE SYSTEM - Maintenance

MONTHLY

- 1.Cleaning & blowing cyclonic filters in reverse direction of normal air flow.
- 2. Record pressure drop across cyclonic filters & baggie filters.

90 DAYS :

- 1.`Renew baggie filters.
- 2.`Visually examine the condition of turbo impeller.

4 YEARLY : Renew turbo clutch.

- **6 YEARLY :** Overhaul turbo & refit.

AIR INTAKE SYSTEM - Maintenance

- **PRESSURE TO BE CHECKED**
- Inertial Filters (Central Air Compartment)
- Minimum 76mm (3”) H2O
- Maximum 178mm (7”) H2O
- Engine + Filter
- Minimum 127mm (5”) H2O
- Maximum 356mm (14”) H2O

Inpsection of Central Air System:

- If any leaks exists in the Central air compartment, then unfiltered air will enter, this is caused by any of the following defects :-

- i. Compartment door not tightly closed due securing bolts missing/gaskets/seals are not properly applied.

- ii. Engine room partition and attached cover plates are not properly secured and closed.

Inpsection of Central Air System:

- iii. Generator pit aspirator not properly connected:-
- a. Check aspirator drain holes for any obstruction.
- b. Check that Traction Motor cooling air is getting exhausted from the aspirator tube at the aspirator drain holes.
- iv. Check whether dust bin blower motor is working and rotating in the correct direction to exhaust the dust particles.
- v. Keep initial filter tubes clean.

Poor Hauling power

- REASON: Booster pressure dropping OR Poor hauling.
- SOLUTONS:
- Fuel oil pressure dropping.
- Exhaust manifold may be given up.
- Turbo super charger may be defective.
- After cooler gasket may be given up.
- Baggy Filters.

Trouble shooting

- **UNUSUAL SOUND FROM TURBO END**
  - Defective Turbo making humming sound.
  - Defective planetary gear train in Turbo.
  - Rubbing of impeller with main casing.
  - AUX.GEN drive unit back lash not adjusted properly.
  - Improper seating of exhaust valve, broken exhaust valves, injector dribbling, defective power assembly.

Trouble shooting

- **BLACK THICK SMOKE FROM TURBO**
  - Chocked air filters.
  - Defective clutch.
  - Turbo air inlet rubber boot worked out and blocking the turbo air inlet passage.
  - Defective injectors.
  - Improper supply of fuel oil.
  - Turbo malfunctions.
  - Improper adjustment of rack
  - Malfunction of Governor.
  - Slippage of injector linkage.

Trouble shooting

- **OIL THROW FROM TURBO**
  - Damaged power assembly.
  - Damaged valve guide.
  - Low crank case vacuum.
  - Clogged eductor.
  - Oil separator oil collecting wire meshes missing.
  - Improper fitment of piston rings, head seat ring (worn out).
- **WATER THROW FROM TURBO :**
  - Cylinder Head crack.
  - Head to Liner gasket leaking.

Trouble shooting

- **LUBE OIL LEAKAGE FROM AIR BOX DRAIN PIPE**
  - Punctured air box drain pipe in sump.
  - Main lube oil header crack.
  - Worn out piston rings.
- **WATER LEAKAGE FROM AIR BOX DRAIN PIPE :**
  - Defective water inlet tube.
  - After cooler tube leakage.
  - Head to liner gasket & joint leakage.
  - Damaged power assembly.
  - Improper fitment of water inlet tube.

ANY QUESTIONS???

THANK YOU.