Description of diesel induction and exhaust system

Objectives: At the end of this lesson you shall be able to
- **state the function of induction system**
- **state the function of exhaust system**

Diesel induction system

In diesel engine only air is drawn into the cylinder from atmosphere through air cleaner, turbocharger, induction manifold, intake port and inlet value. The induction manifold provides passage for the flow of fresh air from air cleaner a turbo charger toward the engine cylinder. The intake value provides entrance for the fresh air charge into the combustion chamber and cylinder. The following air into the flow system is used in diesel induction system.

Air cleaner - Turbo charger - Induction manifold - Intake port - Inlet value - Combustion chamber and cylinder

Diesel exhaust system

The diesel engine used gases go out of the cylinder and combustion chamber through exhaust value, which act as gate to promide exit for the burnt gases. The gases flow out through exhaust value mouth space to the connecting passage of exhaust port into the exhaust manifold. The used exhaust gases from the manifold are let out into the atmosphere through catalystec converter muffler and tail pipe. The catalystic converter reduced the emission from the exhaust gases and muffler silence the noise of exhaust gases by reducing the pressure of the exhaust gases by slow expansion and cooling.

Further exhaust gases used for exhaust broke system to control the vehicle speed and to drive the turbo charge's turbine unit. The flow of exhaust gases.

Engine cylinder - used exhaust gases - exhaust port- exhaust manifold - exhaust braje catalytic converter - muffler - tail pipe- atmosphere.

Aircompressor, exhauster and turbocharger

Objectives: At the end of this lesson you shall be able to
- **explain constructional features of an air compressor**
- **explain operation of an air compressor**
- **explain constructional features of an exhauster**
- **explain operation of an exhauster**
- **explain constructional features of a turbocharger**
- **explain operation of a turbocharger.**

Air Compressor

An air compressor is part of an engine. It is driven either from the timing gear or from the camshaft to maintain air pressure for different purposes.

Normally, it is of a single cylinder type consisting of a piston assembly, connected to the crankshaft by means of a connecting rod. It has an inlet valve and a delivery valve. An aircompressor is having an inbuilt air cooling system with fins on its head. Valves are automatic in action and consist of hardened and lapped spring loaded steel discs against removable seats. Engine lubricating oil is circulated to lubricate the parts of air compressor

Operation

During the downward stroke of piston partial vacuum is created in cylinder which opens the inlet valve, air to enter into the cylinder. During the upward stroke, the pressure closes the inlet valve. So air is compressed in the cylinder which opens the delivery valve sending compressed air to the reservoir.

Exhauster

Vane type exhauster

Exhausters are fitted on diesel engine to develop vacuum to assist the pneumatic governor of F.I.P. A vane type exhauster is held by bolt over an opening in the engine and consists of a rotor, keyed to a shaft. The rotor is mounted eccentrically to the barrel (body) of the exhauster. Vanes are fitted with sliding fit in the slots of the rotor. A shift valve fitted on the exhauster, limits the vacuum to a predetermined pressure.

Impeller type exhauster

The impeller type exhauster has two spindles. One has an impeller. It is driven by auxiliary driving shaft and the other spindle has rotor whose vanes engage with those on the driven rotor.

Operation of exhauster

The vane type exhauster unit works on the principle of centrifugal force. When the engine is running due to centrifugal action, the vanes which have a sliding fit, fit into the slots in the rotor, which come out to the interior surface of the body (barrel). Air is thus evacuated through out the section and is discharged into the crank case. Lubrication for vanes is provided by splash of oil from the crank case.

Supercharges

A supercharger is a device which increase the pressure of the airfuel mixture from the carbutettor before it enters the engine. It is connected between the carburettor and the cylinder in the way of intake manifold. It is usually driven by the engine through suitable gears and shafts. There are three general types of superchargers:

1 Centrifugal type

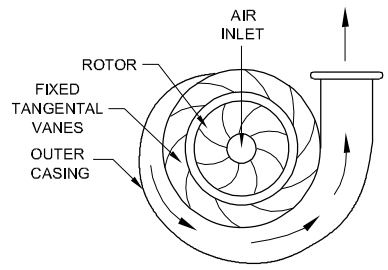
2 Vane type

3 Roots air-blower type

Centrifugal type supercharger (Fig 1)

It consists of an impleller which rotates at a very high speed, about 10,000 r.p.m. The air-fuel mixture enters the impeller at the centre and after passing through the impeller and diffuser vanes goes out of the casing to the engine cylinder. Due to the high spped of the impeller, the mixure is forced into the cylinder at a high pressure.

Fig 1



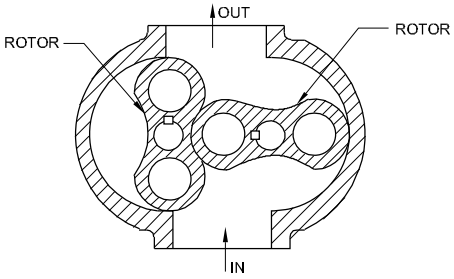
CENTRIFUGAL TYPE
SUPERCHARGER

MDN24110111

Roots air-blower type supercharger (Fig 2)

It consists of two rotors of epicycloid shape. Each rotor is fixed to a shaft by a key. The two shafts are connecred whether by means of gears of eaual size the two rotors rotate at the same speed. The working action of such a supercharger is just like a gear pump, so that the mixture at outlet side is at a high pressure.

Fig 2



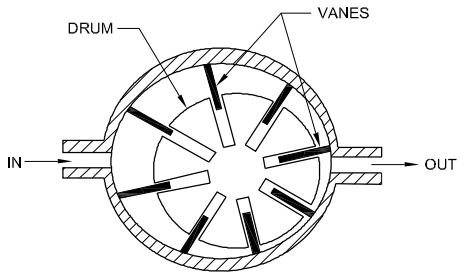
ROOTS AIR-BLOWER TYPE SUPERCHARGE

MDN24110312

Vane type supercharger (Fig 3)

It consists of a drum on which a number of vanes are mounted in such a manner that they can slide in or out against some spring force, so that all the times they are in contact with the inner surface of the surpercharger body. The space berween the body and the drum goes on decreasing from the inlet to the outlet side. Thus, the air-fuel mixture entrapped between any two vane at inlet goes on decreasing in volume and increasing in pressure as in reaches the outlet.

Fig 3



VANE TYPE SUPERCHARGER

MDN24110313

The roots syoercharger is simpler in construction and requries least mainteneace. It ha scomparatively ling life. It works well even at lower speed ranges. Centrifugal type supercharger has poor working charateristics at lower speeds. Vane type supercharger has the problem of wear of vane tips.

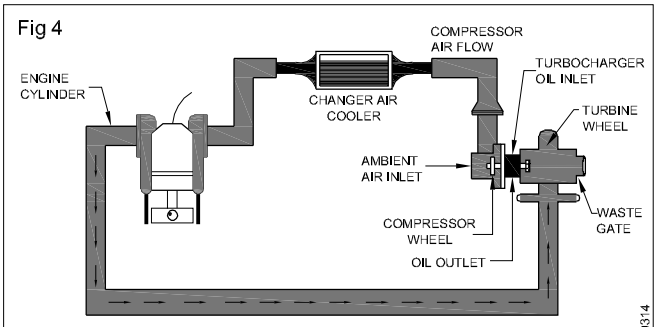
Turbo charger passes compressed hot arrists in color and it heats up expands air the pressure increase from a turbocharger is the result of heating the air before it goes into the engine. In order to incrase the power of the engine and get more air molecules into the cyliner.

The intercooler (Fig 4) is an additional component that looks like a radiator, except that air passes through the inside as well as the outside of the intercooler. The intake air passes through sealed passageways inside the cooler, while cooler air from outside is blown across fins by the engine cooling fan.

Intercooler (Fig 4)

The intercooler further increases the power of the engine by cooling the pressurized air coming out of the compressor before it goes to the engine. The inter cooled system will put cooler air, which is denser and contains more air molecules than warmer air.

Fig 4



INTERCOOLER

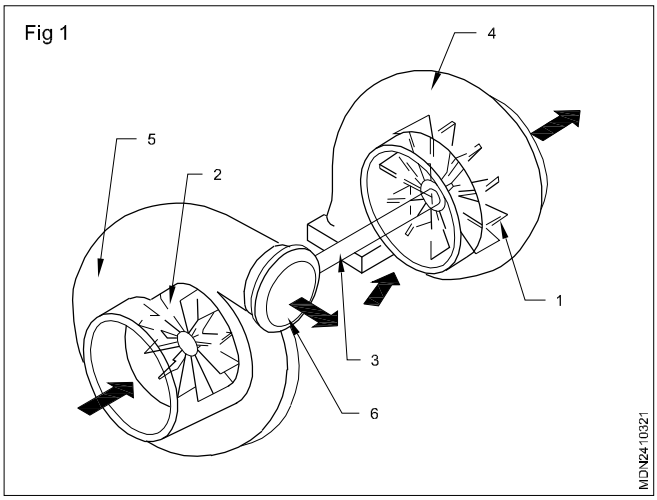
Turbocharger

Objectives: At the end of this lesson you shall be able to
- **explain constructional features of a turbocharger**
- **explain operation of turbo charger**
- **explain types of turbocharger.**

Turbocharger (Fig 1)

Turbo charger is mounted on the engine. It increases the amount of air delivered to the engine cylinder, thereby more fuel can be burnt which increases engine power. Whenever the density of air is less than the density at atmospheric pressure specially at higher altitudes, turbo charges helps the engine to get the sufficient air. An engine may have one or more turbo chargers.

Fig 1



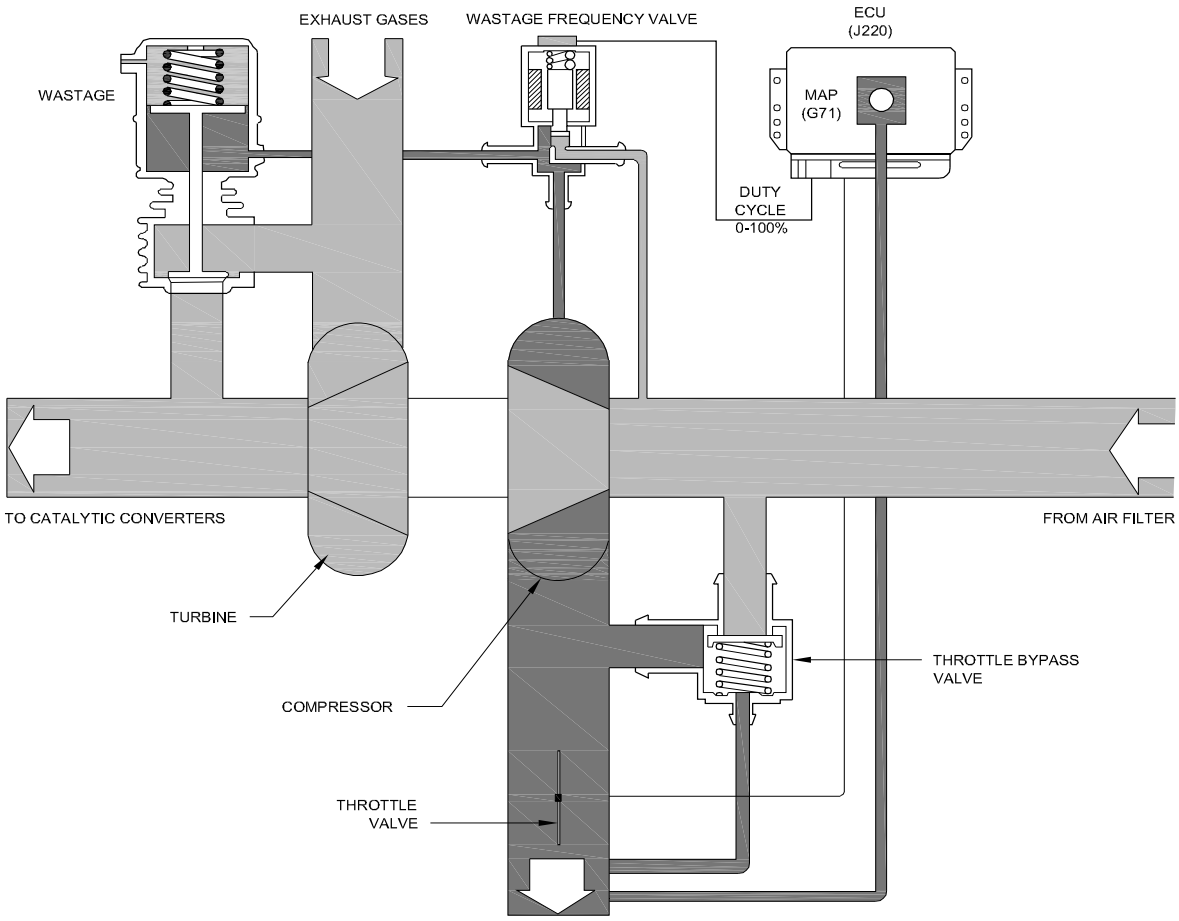
A turbocharger is mounted on the exhaust manifold. It has a turbine wheel (1) and a compressor wheel (2) on the same shaft (3). Exhaust gases enter in turbine housing (4) and rotate the turbine wheel (1). Compressor housing's (5) inlet is connected to the air cleaner and compressed air is discharged to inlet manifold through the outlet (6).

Turbocharger

Fixed Geometry Turbochargers (FGT)

A turbocharger consists of a turbine and a compressor linked by a shared axle. The turbine inlet receives exhaust gases from the engine exhaust manifold causing the turbine wheel to rotate. This rotation drives the compressor, compressing ambient air and delivering it to the air intake manifold of the engine at higher pressure, resulting in a greater amount of the air and fuel entering the cylinder. In FGT, (Fig 2) the amount of compressed air which has to be entered in the engine is controlled by a waste gate valve which regulates the turbo output depending on engine's speed.

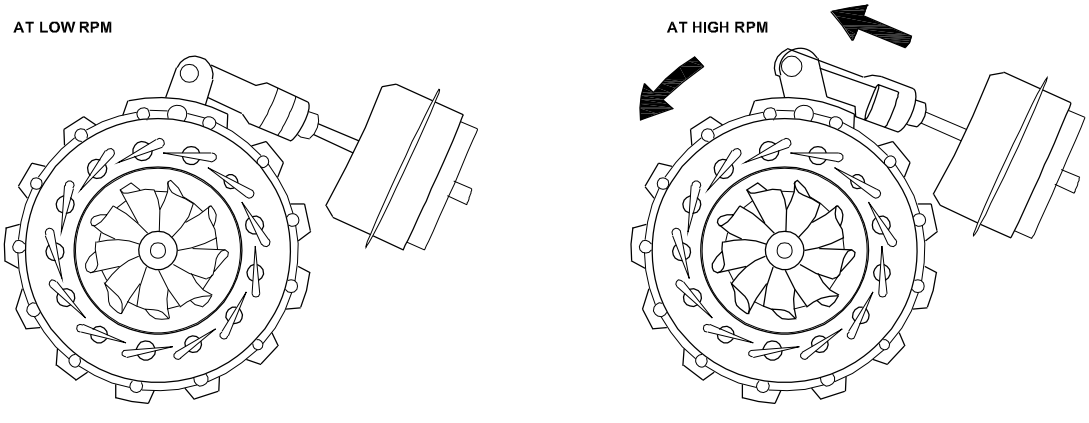
Fig 2



Variable Geometry Turbochargers (VGT)

Variable geometry turbochargers (VGTs) (Fig 3) are a family of turbochargers, usually designed to allow the effective aspect ratio of the turbo to be altered as conditions change. This is done because optimum aspect ratio at low engine speeds is very different from that at high engine speeds. If the aspect ratio is too large, the turbo will fall to create boost at low speeds; if the aspect ratio is too small, the turbo will choke the engine at high speeds, leading to high exhaust manifold pressures, high pumping losses and ultimately lower power output. By altering the geometry of the turbine housing as the engine accelerates, the turbo's aspect ratio can be maintained at its optimum. Because of this, VGTs have a minimal amount of lag, have a low boost threshold, and are very efficient at higher engine speeds.

Fig 3



Air cleaner and air cooler

Objectives : At the end of this lesson you shall be able to
- **state the need of an air cleaner**
- **state the different types of air cleaners**
- **state the function of indication manifold**
- **state the function of an air cleaner.**

Atmospheric air consists of a large quantity of dirt and dust. Uncleaned air will cause faster wear of and damage to the engine parts, so air is filtered before entering inside the cylinder bore.

Purpose of air cleaner

- It cleans the intake air.
- It reduces the noise of the intake air.
- It acts as a flame arrester during engine backfire.

Location

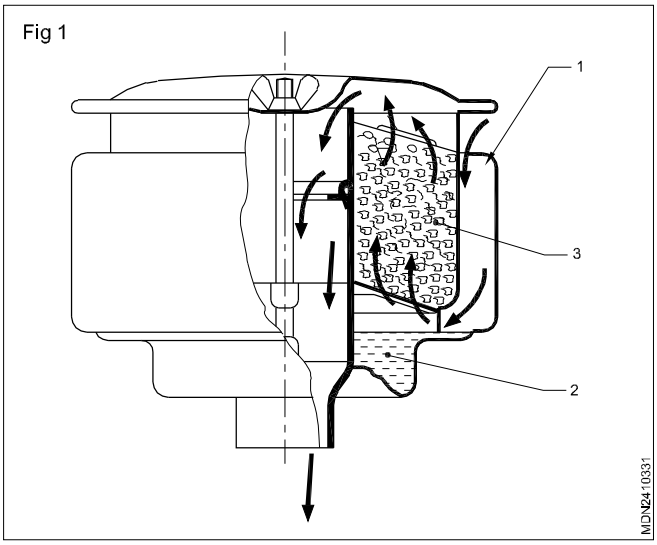
It is mounted on the top of the air inlet manifold.

Types

- Wet-type (Fig 1)
- Dry-type (Fig 2)

Wet type air cleaner

Fig 1

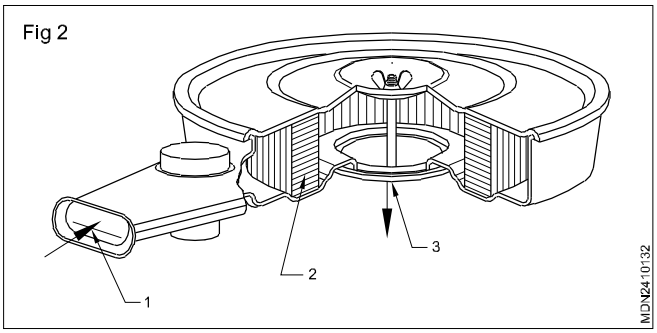


The atmospheric air enters the air cleaner through the side passage (1) and strikes on the surface of the oil (2). Heavy dust particles are absorbed by the oil. The partially filtered air, along with oil particles, moves upward through the filter element (3). Fine particles and oil particles are collected by the filtering element (3). Cleaned air then passes through the passage to the inlet manifold.

Dry type air cleaner

In this type of air cleaner, a specially treated paper element is used to filter the intake air.

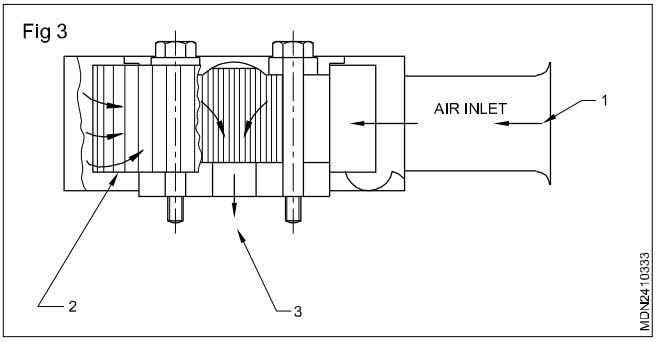
Fig 2



Function

The atmospheric air enters the air cleaner (Fig 3) through the air entrance (1) and passes through the paper element (2). The filtered clean air goes to the intake manifold entrance (3).

Fig 3



Charge air cooler and turbo charger

Charge air cooler and turbo charge are part of a high tech induction system that increases engine combustion efficiency. The turbo charger uses exhaust gases to compress air before it entire the charge - air cooler.

The compressed air going through the charge-air cooler is then cooled by the ambiant air flowing across the cooler fins. The cooled air is more dense than warm air. So when it flow into the intake side of the engine, the increased density improves horse power, fuel economy and reduce the emissions.

Induction manifold

The intake manifold is connected with air cleaner and cylinder head intake port of the cyliner head. It is allow the fresh air to flow from air cleaner to cylinder through inlet valve. The intake manifold is made of a cast iron or aluminium.

Manifolds and silencer

Objectives: At the end of this lesson you shall be able to
- **explain the purpose of the inlet manifold**
- **explain the purpose of the exhaust manifold**
- **explain the purpose of the muffler and tail pipe**
- **explain the constructional features of the mufflers**
- **list out the different types of mufflers.**

Manifolds and silencer

The inlet manifold is used to supply the air-through from the carburettor to the intake ports in the cylinder head. The inlet manifold is generally made of aluminium cast iron.

Fig 1

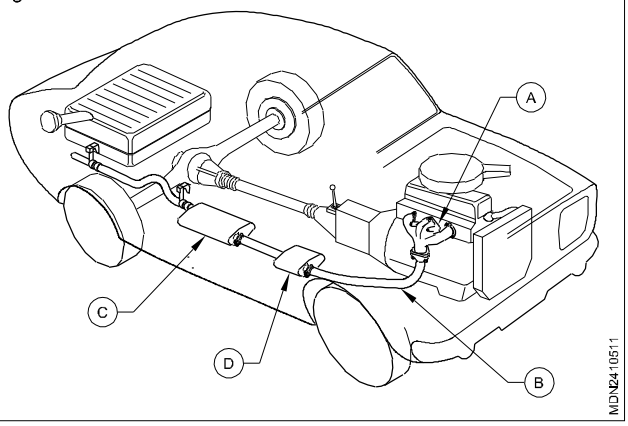
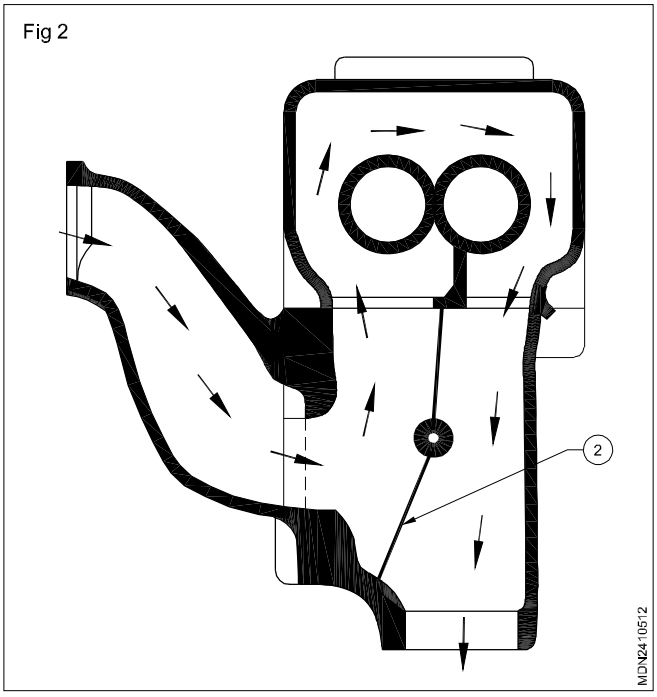


Fig 2



The exhaust manifold (A) is used to collect the exhaust gases from the different cylinders and send them to the silencer. The exhaust manifold is generally made of cast iron. The exhaust manifold may include a heat control valve (Fig 2) or a heat riser which has a thermostatically operated butterfly valve (2) fitted in exhaust manifold. (Fig 2) When the engine is cold, the valve is closed and hot gases are directed around the inlet manifold. When the engine attains operating temperature the valve opens and the exhaust gases are directly sent to the muffler.

Exhaust pipes

The exhaust pipe takes the burnt gases from the manifold to the muffler. The pipes are steel tubes, suitably shaped and routed below the chassis to lead the gases away from the vehicle at the rear and to direct the gases down and under the vehicle. It is kept in place by flanges or clamps at either end. In some vehicles, a flexible mounting to the body or chassis is used.

Muffler

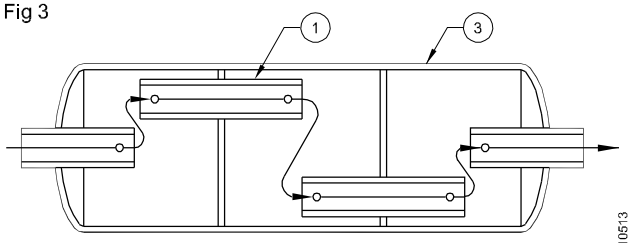
The muffler (C) (Fig 1) is normally located under the body of the vehicle and attached to the body or chassis with flexible mountings. In some trucks in which exhaust gases are directed upward, the muffler is mounted at the rear end of the cab and surrounded with a guard to prevent accidental touching. The muffler reduces the engine exhaust noise. It is a large cylindrical shaped container, fitted with passages and chambers that absorb and dampen the noise of the exhaust gases. Often a small or pre-muffler (D) is fitted in the exhaust system between the manifold and the main muffler.

Types of mufflers

i Reverse flow muffler (Fig 3)

In this type, small pipes (1) (Fig 3) are placed in the housing (3) of the muffler. Exhaust gases flow in a zigzag way, thus reducing the sound, by travelling through a longer length.

Fig 3

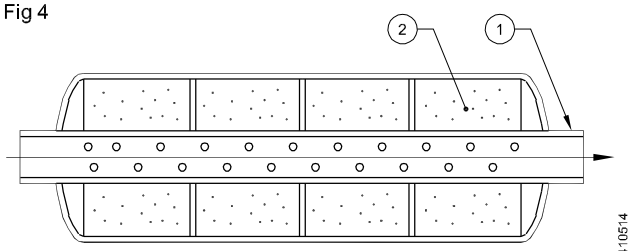


REVERSE-FLOW MUFFLER

ii Straight through muffler

In this type a straight perforated tube (1) (Fig 4) is placed throughout the length of the muffler. Glass wool or steel wool (2) is filled in between the perforated tube and the muffler housing, which acts as a sound absorbent.

Fig 4

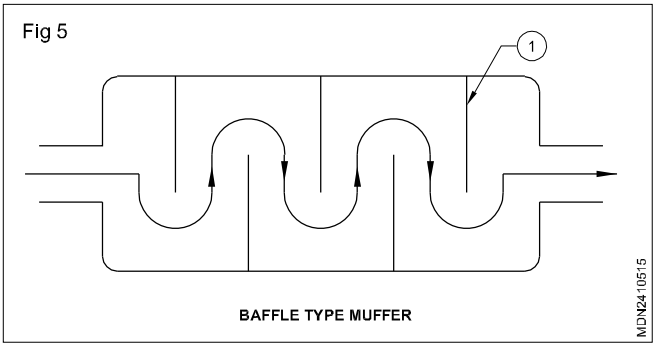


STRAIGHT-THROUGH MUFFLER

iii Baffle type

In this type, a series of baffles (1) (Fig 5) are placed in the muffler which causes restriction and back pressure to the exhaust gases, thereby reducing the sound of the exhaust gases.

Fig 5



BAFFLE TYPE MUFFER

Skill Information

Mufflers

Objectives: At the end of this lesson you shall be able to
- **describe the back pressure**
- **describe the back pressure muffler**
- **describe the electronic muffler.**

Back pressure

Any restriction to exhaust flow in the exhaust system creates back-pressure. Some back-pressure can be beneficial, excessive back-pressure reduces volumetric efficiency and reduces engine efficiency.

Variable flow exhaust/Back pressure muffler

A movable valve fitted within the exhaust system is used to change the amount of exhaust back-pressure. At higher engine speeds when exhaust noise levels are unacceptable, the valve is closed, thus reducing the bore of the exhaust. This enables greater back-pressure and noise reduction is the result. The valve can be operated by

- Pneumatics - exhaust gas pressure
- Electronics - a computer

When a variable flow exhaust is added to the baffle and chamber system, quieter noise emissions are the result. This is because the system can partially respond to changes in engine speed and load.

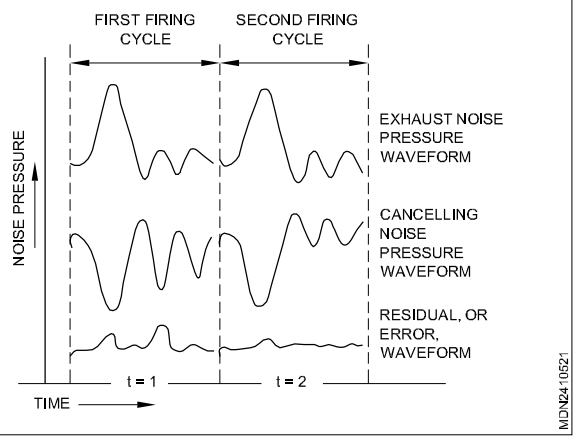
Electronic mufflers

Electronic mufflers are designed to produce anti noise without restricting exhaust flow. This computer-controlled system uses a microphone to detect the sound waves produced within the exhaust system. As the exhaust gas leaves the tail pipe, computer driven loudspeakers are operated to generate the correct amount of anti-noise.

The result is virtually silent exhaust without generating additional and unwanted back-pressure across all engine operating conditions. This increases fuel economy and reduces exhaust emissions.

Sensors and microphones pick up the pattern of the pressure waves an engine emits from its exhaust pipe (Figure 1 & 2). This data is analyzed by a computer. A mirror-image pattern of pulses is instantly produced and sent to speakers mounted near the exhaust outlet. Opposite waves are created that cancel out the noise. Noise is removed without creating back pressure in the muffler. Electronic mufflers can be designed to emit certain sounds or no sound at all.

Fig 1



Extractor manifolds

The extractor exhaust manifold system for an internal combustion engine, which improves its efficiency by sing precise geometry to reflect the pressure waves form the exhaust value at a particular time in the cyle.

Advatagees of extractor manifold

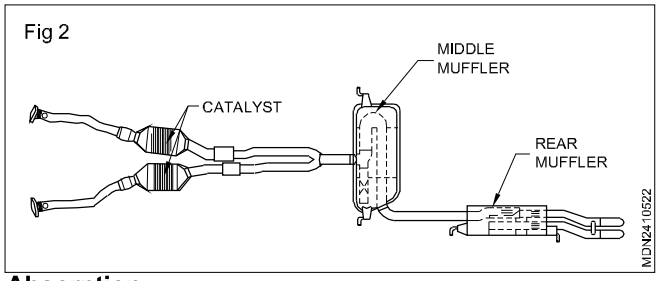
- Separating the gas flow from the individual cylinders.
- Avoid the inter cylinder gas interference
- Maintaining an optimum gas velocity by chosen tube diameter
- Allowing the individual cylinders to assist one anoter where the individual exhausts merge.

This type of exhaust system can be used with or without a muffker and so can be used on both race and road vehicles.

Absorption mufflers in exhaust system

This type of mufflers are almost indispenble element of modern exhaust systems. The absorption material is just modern exhaust systems. The absorption material is just as important as a calculation method for designing the mufflers in order to ensure that they are optimally used.

Fig 2



Absorption

Automotive exhaust noise can be attenuated is several ways. A distinction is generally made between active and passve attenuation. The modern engine exhaust system consist of more than one abosorption muffler to reduce the noise and pollution. The absorption mufflers are disspate the sound energy through the use of porous materials.

Noise absorbtion components

Reactive / abosorption silencers in single package unit

Flexible connection

The exhaust pipe takes the burning gases from the exhaust manifold. The silencer pipes are fitted under the chasis body to lead the exhaust gases away from the manifold. The silencer pipes are mounting with flexible connection to the chasis or body of the vehicle. The flexible connection is prevent from damages by heavy jerks or rough up and down movement of the vehicles.

Ceramic coating

Ceramic coating is capable of with standing of high temperature and it has very good chemical and corrosion resistance and possess excellent thermal barrier characteristics, providing a dramatic reduction in radiated heat. It is self-cleaning properties last for upto 5 years.

Ceramic coatings contain the gaseous heat with in exhaust pipes. The causes the gasses to heat up and expand as a result exhaust flow is boosted.