IC Engine System

Intake and Exhaust System

The intake and exhaust system deals with the inflow *of* fresh air and the outflow of used gases in the engine.

AIR INTAKE SYSTEM

This system allows fresh air to enter the engine. Its main parts are: (i) air cleaner, (ii) supercharger (auxiliary unit), (iii) intake manifold, (iv) intake port and (v) intake valve.

AIR CLEANER

The operating efficiency, good performance and durability of an engine depend mainly upon its cleaner. It is a device, which cleans and filters the air before entering the combustion chamber of an engine.

An IC engine uses large quantities of air for combustion, the ratio being 14-15 lb of air for every lb of fuel bursts. The volume of the air used is about 10,000 gal/gal of fuel. Unfiltered air may contain millions of particles of abrasive dust and other matter, which could cause rapid wear.

There are many types of air cleaners but the types commonly used in tractors are:

(i) Oil wetted mesh type,

(ii) Dry air type and

(iii) Wet type or oil bath air cleaners.

OIL WETTED MESH AIR CLEANER

It consists of a copper mesh or nylon wire wetted with oil to catch the dust particles from the air which are made to pass through it. This type, however, gets clogged with dust quickly, thus, seriously affecting the air flow through it and rendering it inefficient in removing the fine particles of dust from the air.

DRY AIR CLEANER

This type of air cleaners contains three main parts, viz. pre-cleaner, main housing and cleaning element. These are sealed into one unit. The main housing contains the cleaning element, usually of multi-wire netting, but some are made of nylon hair or paper. The air from the atmosphere enters from the pre-cleaner, passes through the cleaning element and goes to the inlet manifold. The paper filter element is cleaned after 50-100 hours of service.

Dry air cleaners are mounted (i) vertically in front of the tractor radiator and (ii) horizontally on the overhead engine.

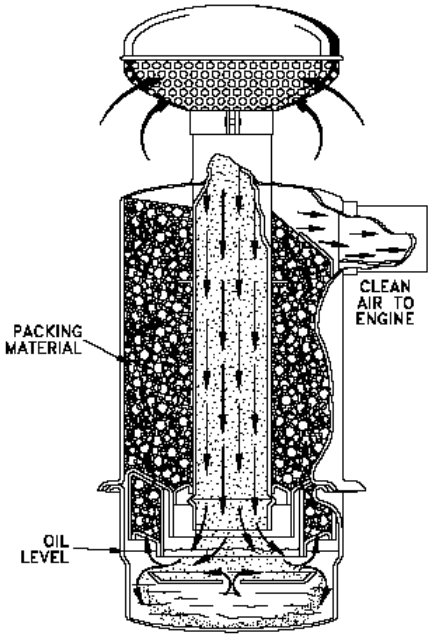
The following are the advantages of the dry air cleaner:

1. Easy to service.
2. Good performance in gradient and in rough fields.
3. More efficient at high speeds.
4. Straw and chaff cause less restriction to air passage.

Its main disadvantages are:

1. It is costlier to maintain than an oil bath because the filter elements require replacements very often.
2. Sometimes, dust particles enter the cylinder

OIL BATH AIR CLEANERS The main difference between a dry and oil bath cleaner is that in the latter type, oil is used for cleaning air. Water bath cleaners were also in use in earlier times. But now the oil bath cleaner have come into more common use. This type of cleaner operates on the principle of having the air with dust enter the intake stack, pass down the inlet passage over the oil surface, where some of the oil is picked up, atomized and carried up into a separating screen. As the air passes through a screen (filter) most of the remaining dirt is attached to the oil wetted surfaces and drains back into the sump. The air outlet is on the side through which the clean air enters the cylinders. In the bottom a removable cup is fitted for convenient cleaning and servicing. Oil bath air cleaners are always mounted vertically to the engine, thus the oil remains in the cup at the bottom of the cleaner. It is often mounted either in front of the radiator or by the side of the engine.



Tractor engine:

Tractors always work in dusty conditions. In order to prolong the engine life, pre-cleaners are fitted in the upper portion of the main cleaner. When the engine is running, the air is drawn through the pre-cleaner to the inlet tube of the main cleaner. Here large dust particles are removed from the air stream, thus reducing much of the load on the main cleaner.

The pre-cleaner functions on the centrifugal principle. By means of vanes and baffles it gives a

rotary motion to the air, thus causing the heavier dust particles to be thrown out due to centrifugal force and the pre-cleaned air passing to the cleaner.

SUPERCHARGERS

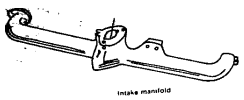
A supercharger is a device for increasing the air pressure into the engine so that more fuel can be burnt and the engine output increased. The pressure inside the manifold of a supercharger engine will be greater than the atmosphere pressure. Supercharged air is provided either by positive displacement rotary blowers or by centrifugal blowers. These may belt driven by engine it self or from a separate power source such as electric motor or from exhaust gas turbine

INLET MANIFOLD

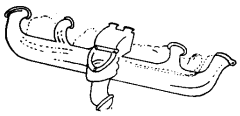
The inlet manifold is required to deliver into the cylinders either a mixture of fuel and air from the carburetor or only air from air-cleaners. The inlet manifolds are made in one or two pieces either from cast iron or aluminium alloy. They are also bolted from separate castings into a single unit. The manifold flanges are connected to the cylinder block or cylinder head by means of asbestos-copper gaskets, studs and nuts.

EXHAUST SYSTEM

The exhaust system collects exhaust gases from the engine and expels them out. The system consists of: (i) exhaust valve, (ii) exhaust port (iii) exhaust manifold, (iv) turbo charger (auxiliary unit) and (v) muffler.



EXHAUST MANIFOLD



The exhaust manifold collects exhaust gases from the exhaust ports of various cylinders and conducts them from each end to a central exhaust passage. It is usually made of cast iron. The exhaust manifolds are designed to avoid the overlapping of exhaust strokes as much as possible, thus keeping the back pressure to a minimum. This is often done by dividing the exhaust manifold into two or more branches so that no two cylinder will exhaust into the same branch at the same time.

TURBOCHARGER

This is an exhaust driven turbine, which drives a centrifugal compressor wheel. The compressor passage is usually located between the air cleaner and engine intake manifold, while the turbine is located between the exhaust manifold and muffler.

MUFFLER

The muffler reduces the noise of the exhaust gases by reducing the pressure of the used gases by

slow expansion and cooling. On the other hand, the muffler must not cause any appreciable restriction to the flow of oil that could raise the backpressure excessively. The muffler contains a number of chambers through which the gas flows. The gas is allowed to expand from the first passage into a *much* larger second one and then to a still larger third one and so on, to the final and largest passage which is connected to the tail (outlet) pipe of muffler.

The following steps are required for the proper care of the inlet and exhaust system.

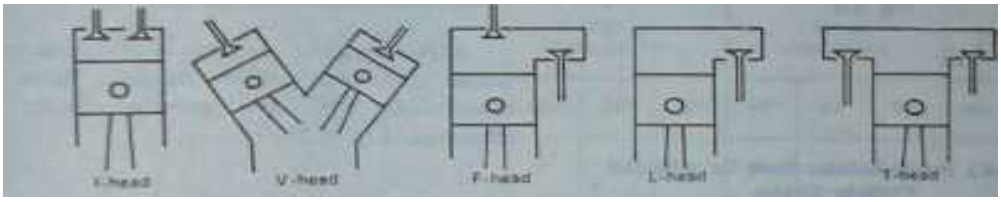
1. The inlet and exhaust manifolds should be checked for air leaks and the nuts and connections tightened at regular intervals.

2. A clogged muffler exhaust pipe or tail pipe will cause a backpressure on the pistons and a loss of power. Therefore, it must be cleaned every time during service. Sometimes, the engine overheats due to excessive carbon deposit.

Engine Valve Timing

Arrangement of valves:

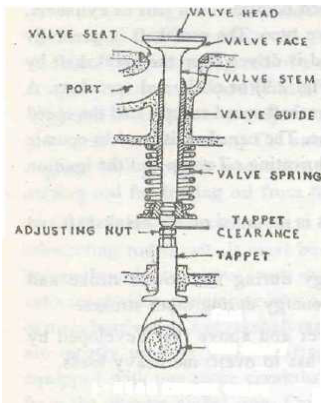
The valve arrangements are generally classified as L-head, I-head, T-head and F-head according to the arrangements of the valves. In the L-head design, both the inlet and exhaust valves are on one side of the engine. Sometimes it is called the side valve engine and is operated by a single camshaft, whereas the T-head engine requires two camshafts, with valves arranged in block. The I-head engine is also known as *overhead valve engine*



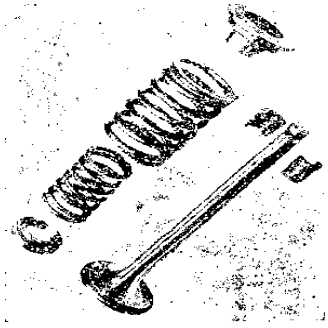
VALVE OPERATION AND RECONDITIONING

The valves of an internal combustion engine are meant lo admit air or air-fuel mixture into the cylinder and finally to let the exhaust gases go out. Poppet type valves are used for this purpose. Most engines are provided with one inlet and one exhaust valve for each cylinder. These valves are usually of equal size, though sometimes the inlet valves are made larger in size than exhaust valves. The arrangement of the valves on the engine may be either over-head type or L-head type. In the over-head arrangement, the valve stem is surrounded by a removable guide and spring holds the valve against seat. The rocker arm assembly, which is operated by a camshaft through a push rod, forces the valves open at the desired time. Due to constant use,

both inlet and exhaust valves and their seats are subjected to mechanical wear. To overcome this, a separate valve seat of high wear resisting material is inserted. It can be replaced by a new piece after it has worn out. To take care of similar mechanical wear, the valve face is generally made of heat resisting alloys.



Parts of a valve system



Poppet type valve system

Clearance between the rocker arm and valve stem is provided to enable to the valves to seat properly. This clearance is also known as tappet clearance, and should be adjusted with feeler gauge according to the manufacture's specifications. The valve tappet clearance is adjusted when both the valves are in **the** shut position. A typical value of valve tappet clearance is given as 0.38 mm (0.015 in).

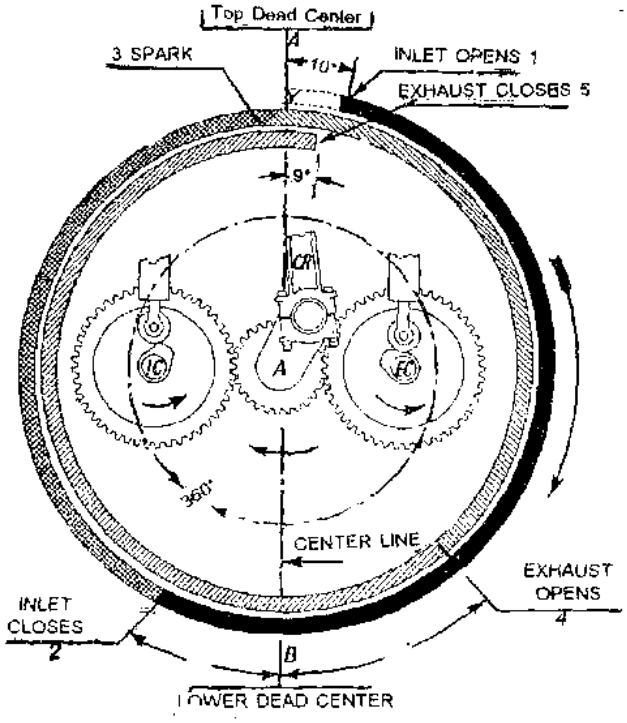
VALVE TIMING DIAGRAM

A typical valve-timing diagram of a vertical engine designed to operate at 800 r.p.m. is shown in Figure. Few observations made are listed below:

1. Inlet valve begins to open shortly after the piston has reached the top dead centre. It continues to remain open till the piston has passed 30 degrees over the bottom (lower) dead centre. Total time through which the valve remains open.

$$\frac{200\times 60}{360\times 800}=\frac{1}{24}\quad \text{sec}\,onds$$

2. Both inlet and exhaust valves remain closed during the compression stroke and most of the time in the power stroke. In terms of crank angle, both, the valves remain closed for about 285 degrees.



3. On the power stroke the exhaust valve begins to open between 30 and 45 degrees before bottom dead centre and it continues to open till the piston has passed over the top dead centre. Thus the exhaust valve remains open about 225 degrees or about

$$\frac{225\times 60}{360\times 800}=\frac{1}{21}\quad \text{sec}onds$$