

**FOUR STROKE ENGINE**  
**A Synopsis Submitted**  
**in Partial Fulfillment of the Requirement**  
**for the Degree of**

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**LUCKNOW**  
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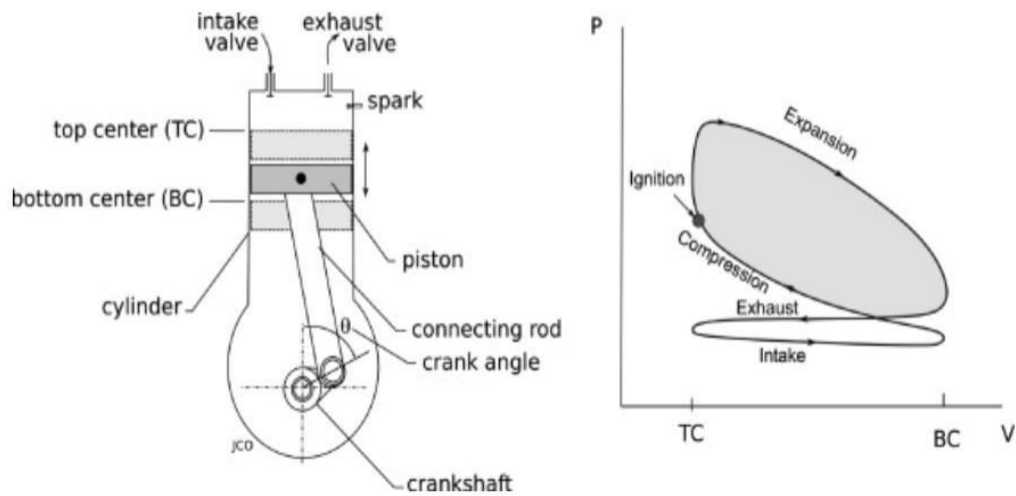


Fig 1.1

A four-stroke (also four-cycle) engine is an internal combustion (IC) engine in which the piston completes four separate strokes while turning the crankshaft. A stroke refers to the full travel of the piston along the cylinder, in either direction.

The four separate strokes are termed:

## **INTAKE**

Also known as induction or suction. This stroke of the piston begins at top dead centre (T.D.C.) and ends at bottom dead centre (B.D.C.). In this stroke the intake valve must be in the open position while the piston pulls an air-fuel mixture into the cylinder by producing vacuum pressure into the cylinder through its downward motion. The piston is moving down as air is being sucked in by the downward motion against the piston.

## **COMPRESSION**

This stroke begins at B.D.C, or just at the end of the suction stroke, and ends at T.D.C. In this stroke the piston compresses the air-fuel mixture in preparation for ignition during the power stroke (below). Both the intake and exhaust valves are closed during this stage.

## **COMBUSTION**

Also known as power or ignition. This is the start of the second revolution of the four stroke cycle. At this point the crankshaft has completed a full 360 degree revolution. While the piston is at T.D.C. (the end of the compression stroke) the compressed air-fuel mixture is ignited by a spark plug (in a gasoline engine) or by heat generated by high compression (diesel engines), forcefully returning the piston to B.D.C. This stroke produces mechanical work from the engine to turn the crankshaft.

### **• EXHAUST:-**

Also known as outlet. During the exhaust stroke, the piston, once again, returns from B.D.C. to T.D.C. while the exhaust valve is open. This action expels the spent air-fuel mixture through the exhaust valve.

These four strokes can also be referred to as "suck, squeeze, bang, blow" respectively, which can be easier to remember. Four-stroke engines are the most

common internal combustion engine design for motorized land transport, being used in automobiles, trucks, diesel trains, light aircraft and motorcycles. The major alternative design is the two-stroke cycle. The exhaust emissions from four stroke engines, like other combustion engines, contain significant quantities of greenhouse gases, as well as other forms of air pollution. The use of four stroke engines in cars and other transport applications is scheduled to be phased out in some jurisdictions, and as of 2022 other major jurisdictions are considering similar

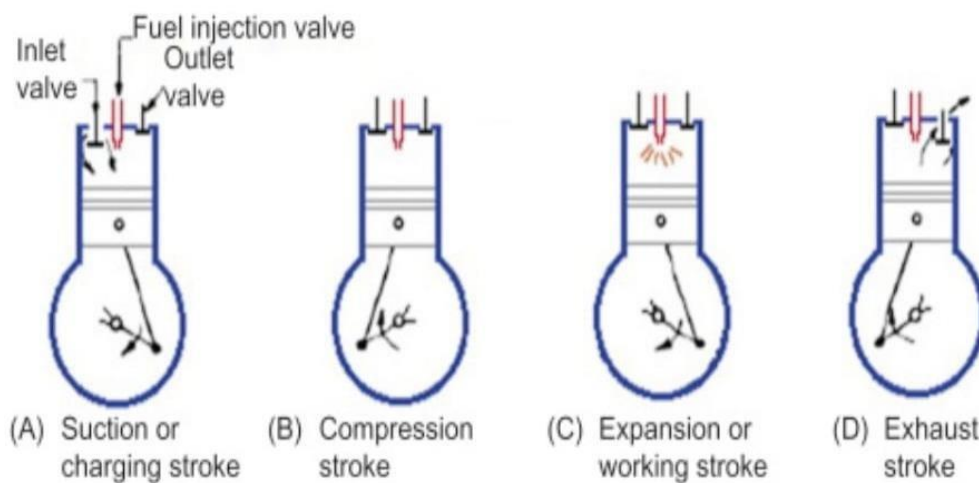


Fig 1.2

## FUEL CONSIDERATION

A problem with compressed charge engines is that the temperature rise of the compressed charge can cause pre-ignition. If this occurs at the wrong time and is

too energetic, it can damage the engine. Different fractions of petroleum have widely varying flash points (the temperatures at which the fuel may self-ignite). This must be taken into account in engine and fuel design. The tendency for the compressed fuel mixture to ignite early is limited by the chemical composition of the fuel. There are several grades of fuel to accommodate differing performance levels of engines. The fuel is altered to change its self-ignition temperature. There are several ways to do this. As engines are designed with higher compression ratios the result is that pre-ignition is much more likely to occur since the fuel mixture is compressed to a higher temperature prior to deliberate ignition. The higher temperature more effectively evaporates fuels such as gasoline, which increases the efficiency of the compression engine. Higher compression ratios also mean that the distance that the piston can push to produce power is greater (which is called the expansion ratio). The octane rating of a given fuel is a measure of the fuel's resistance to self-ignition. A fuel with a higher numerical octane rating allows for a higher compression ratio, which extracts more energy from the fuel and more effectively converts that energy into useful work while at the same time preventing engine damage from pre-ignition. High Octane fuel is also more expensive. Many modern four-stroke engines employ gasoline direct injection or GDI. In a gasoline direct-injected engine, the injector nozzle protrudes into the combustion chamber. The direct fuel injector injects gasoline under a very high pressure into the cylinder during the compression stroke, when the piston is closer to the top. Diesel engines by their nature do not have concerns with pre-ignition.



They have a concern with whether or not combustion can be started. The description of how likely Diesel fuel is to ignite is called the octane rating. Because Diesel fuels are of low volatility, they can be very hard to start when cold. Various techniques are used to start a cold Diesel engine, the most common being the use of a glow plug.

## **DESIGN AND ENGINEERING PRINCIPLE**

The maximum amount of power generated by an engine is determined by the maximum amount of air ingested. The amount of power generated by a piston engine is related to its size (cylinder volume), whether it is a two-stroke engine or four-stroke design, volumetric efficiency, losses, air-to-fuel ratio, the calorific value of the fuel, oxygen content of the air and speed (RPM). The speed is ultimately limited by material strength and lubrication. Valves, pistons and connecting rods suffer severe acceleration forces. At high engine speed, physical breakage and piston ring flutter can occur, resulting in power loss or even engine destruction. Piston ring flutter occurs when the rings oscillate vertically within the piston grooves they reside in. Ring flutter compromises the seal between the ring and the cylinder wall, which causes a loss of cylinder pressure and power. If an engine spins too quickly, valve springs cannot act quickly enough to close the valves. This is commonly referred to as 'valve float', and it can result in piston to valve contact, severely damaging the engine. At high

speeds the lubrication of piston cylinder wall interface tends to break down. This limits the piston speed for industrial engines to about 10 m/s.

## **INTAKE/EXHAUST PORT FLOW:-**

The output power of an engine is dependent on the ability of intake (air–fuel mixture) and exhaust matter to move quickly through valve ports, typically located in the cylinder head. To increase an engine's output power, irregularities in the intake and exhaust paths, such as casting flaws, can be removed, and, with the aid of an air flow bench, the radii of valve port turns and valve seat configuration can be modified to reduce resistance. This process is called porting, and it can be done by hand or with a CNC machine.

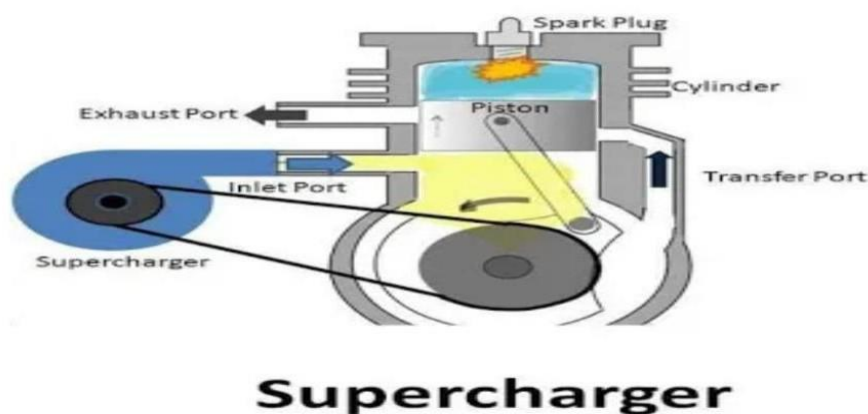


Fig 1.3

## **SUPERCHARGING:-**

One way to increase engine power is to force more air into the cylinder so that more power can be produced from each power stroke. This can be done using some type of air compression device known as a supercharger, which can be powered by the engine crankshaft. Supercharging increases the power output limits of an internal combustion engine relative to its displacement. Most commonly, the supercharger is always running, but there have been designs that allow it to be cut out or run at varying speeds (relative to engine speed). Mechanically driven supercharging has the disadvantage that some of the output power is used to drive the supercharger, while power is wasted in the high pressure exhaust, as the air has been compressed twice and then gains more potential volume in the combustion but it is only expanded in one stage.

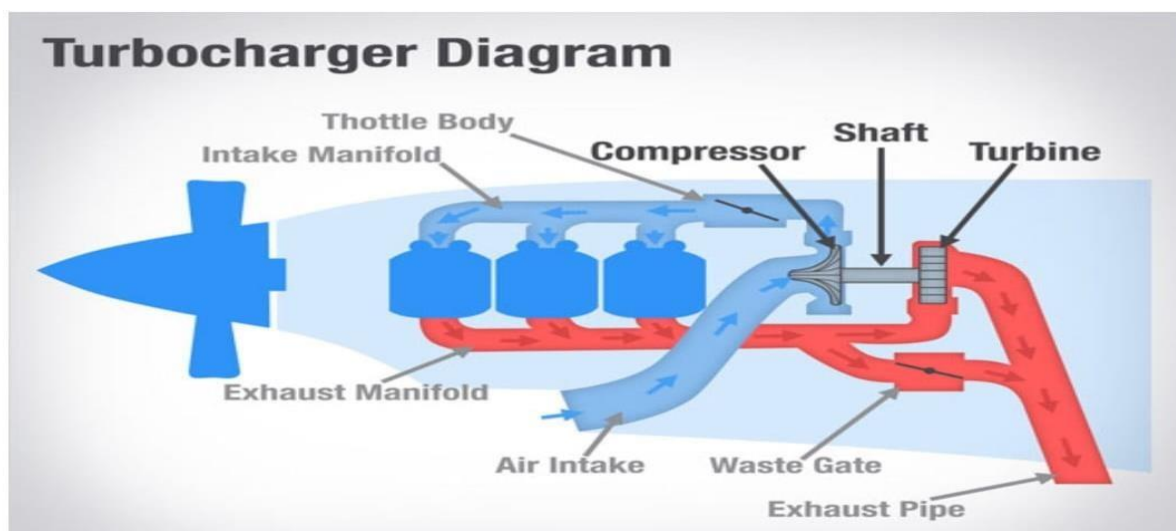


Fig 1.4

## **TURBOCHARGING:-**

A turbocharger is a supercharger that is driven by the engine's exhaust gases, by means of a turbine. A turbocharger is incorporated into the exhaust system of a vehicle to make use of the expelled exhaust. It consists of a two piece, high-speed turbine assembly with one side that compresses the intake air, and the other side that is powered by the exhaust gas outflow. When idling, and at low-to-moderate speeds, the turbine produces little power from the small exhaust volume, the turbocharger has little effect and the engine operates nearly in a naturally aspirated manner. When much more power output is required, the engine speed and throttle opening are increased until the exhaust gases are sufficient to 'spool up' the turbocharger's turbine to start compressing much more air than normal into the intake manifold. Thus, additional power (and speed) is expelled through the function of this turbine. Turbocharging allows for more efficient engine operation because it is driven by exhaust pressure that would otherwise be (mostly) wasted, but there is a design limitation known as turbo lag. The increased engine power is not immediately available due to the need to sharply increase engine RPM, to build up pressure and to spin up the turbo, before the turbo starts to do any useful air compression. The increased intake volume causes increased exhaust and spins the turbo faster, and so forth until steady high power operation is reached. Another difficulty is that the higher exhaust pressure causes the exhaust gas to transfer more of its heat to the mechanical parts of the engine.

## VALVE TRAIN

The valves are typically operated by a camshaft rotating at half the speed of the crankshaft. It has a series of cams along its length, each designed to open a valve during the appropriate part of an intake or exhaust stroke. A tappet between valve and cam is a contact surface on which the cam slides to open the valve. Many engines use one or more camshafts "above" a row (or each row) of cylinders, as in the illustration, in which each directly actuates a valve through a flat tappet. In other engine designs the camshaft is in the crankcase, in which case each cam usually contacts a push rod, which contacts a rocker arm that opens a valve, or in case of a flathead engine a push rod is not necessary. The overhead cam design typically allows higher engine speeds because it provides the most direct path between cam and valve. The rod-to-stroke ratio is the ratio of the length of the connecting rod to the length of the piston stroke. A longer rod reduces sidewise pressure of the piston on the cylinder wall and the stress forces, increasing engine life. It also increases the cost and engine height and weight. A "square engine" is an engine with a bore diameter equal to its stroke length. An engine where the bore diameter is larger than its stroke length is an over square engine, conversely, an engine with a bore diameter that is smaller than its stroke length is an under square engine.

## **ENERGY BALANCE**

Otto engines are about 30% efficient; in other words, 30% of the energy generated by combustion is converted into useful rotational energy at the output shaft of the engine, while the remainder being lost due to waste heat, friction and engine accessories. There are a number of ways to recover some of the energy lost to waste heat. The use of a turbocharger in diesel engines is very effective by boosting incoming air pressure and in effect, provides the same increase in performance as having more displacement. The Mack Truck company decades ago, developed a turbine system that converted waste heat into kinetic energy that it fed back into the engine's transmission. In 2005, BMW announced the development of the turbo steamer, a two-stage heat-recovery system similar to the Mack system that recovers 80% of the energy in the exhaust gas and raises the efficiency of an Otto engine by 15%. By contrast, a six-stroke engine may reduce fuel consumption by as much as 40%. Modern Engine are often intentionally built to be slightly less efficient than they could otherwise be. This is necessary for emission controls such as exhaust gas recirculation and catalytic converters that reduce smog and other atmospheric pollutants. Reductions in efficiency may be counteracted with an engine control unit using lean burn techniques.

# **PERFORMANCE PARAMETERS AND ENERGY DISTRIBUTION OF PETROL ENGINE**

ENGINE Performance is used term which has to do with the power and efficiency obtainable when an engine is operated at various speed, inlet pressure and temperature, fuel-air ratio, spark advance, compression ratio, etc. For comparing the performance of the engine, it needs to know the power and the efficiency of the engine. A. Brake Power and Indicated Power Indicated horsepower is the power that the engine develops inside the combustion chambers during the combustion process. A special device is required to measure pressures in the engine cylinders.

## Power output limitations

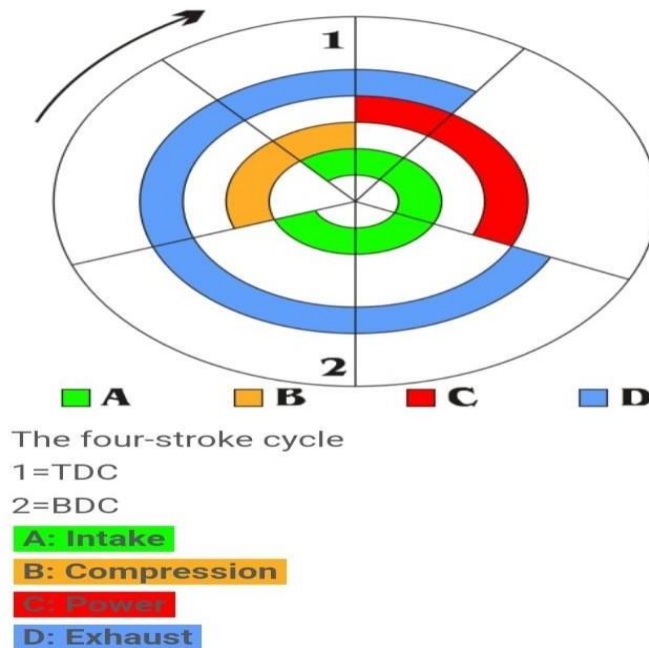


Fig 1.5

## THERMODYNAMIC ANALYSIS

The thermodynamic analysis of the actual four-stroke and two-stroke cycles is not a simple task. However, the analysis can be simplified significantly if air standard assumptions are utilized. The resulting cycle, which closely resembles the actual operating conditions, is the Otto cycle. During normal operation of the engine, as the air/fuel mixture is being compressed, an electric spark is created to ignite the mixture. At low rpm this occurs close to TDC (Top Dead Centre). As



engine rpm rises, the speed of the flame front does not change so the spark point is advanced earlier in the cycle to allow a greater proportion of the cycle for the charge to combust before the power stroke commences. This advantage is reflected in the various Otto engine designs; the atmospheric (non-compression) engine operates at 12% efficiency whereas the compressed-charge engine has an operating efficiency around 30%.

## **WASTE HEAT RECOVERY OF AN INTERNAL COMBUSTION ENGINE**

An internal combustion engine is on average capable of converting only 40-45% of supplied energy into mechanical work. A large part of the waste energy is in the form of heat that is released to the environment through coolant, fins etc. If somehow waste heat could be captured and turned to mechanical energy, the engine's performance and/or fuel efficiency could be improved by improving the overall efficiency of the cycle. It has been found that even if 6% of the entirely wasted heat is recovered it can increase the engine efficiency greatly. Many methods have been devised in order to extract waste heat out of an engine exhaust and use it further to extract some useful work

# REFERENCE

1. Ralph Stein (1967). The Automobile Book. Paul Hamlyn Ltd
2. ["Auto Tech: Atkinson Cycle engines and Hybrids"](#). *Autos.ca*
3. ["Four-stroke engine: how it works, animation"](#). *testingautos.com*.