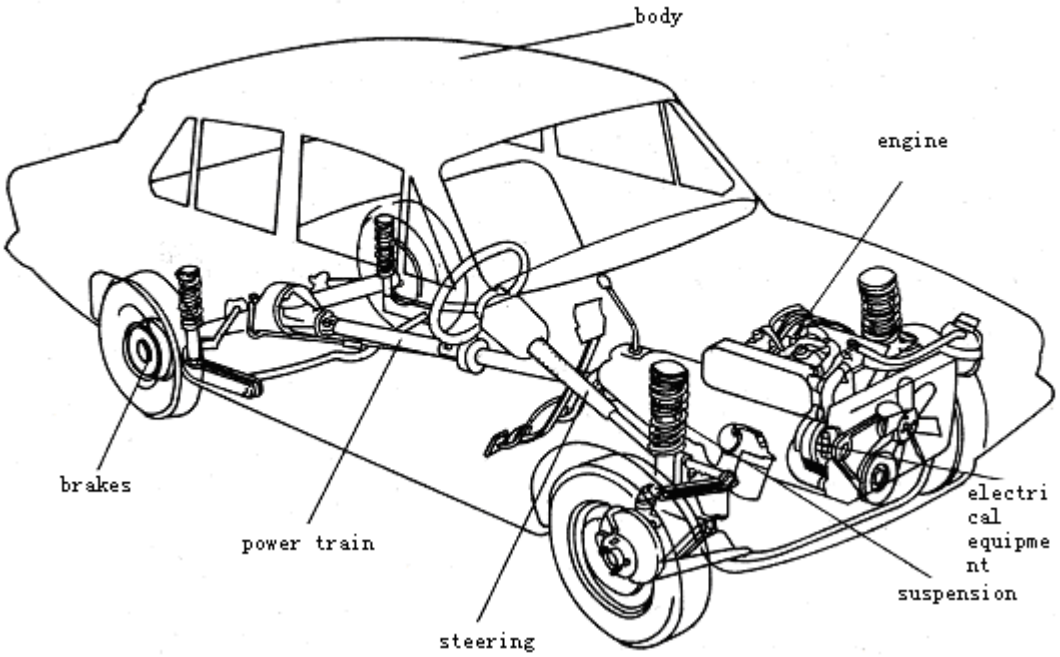
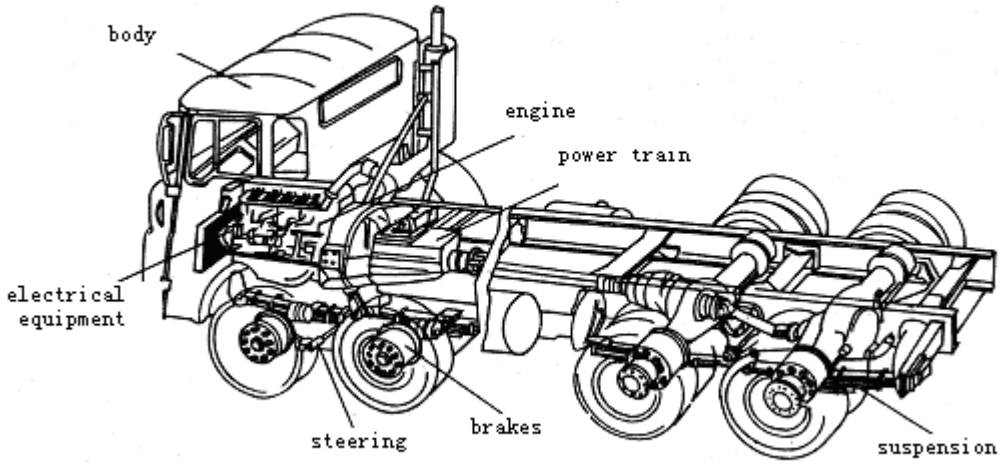
CHAPTER 1 AUTOMOTIVE BASICS

1.1 Principal Components

Today's average car contains more than 15,000 separate, individual parts that must work together. These parts can grouped into four major categories: engine, body, chassis and electrical equipment.



layout of a passenger car



layout of a commercal vhicle

1.2 Engine

The engine acts as the power unit. The internal combustion engine is most common: this obtains its power by burning a liquid fuel inside the engine cylinder. There are two types of

engine :gasoline(also called a spark-ignition engine) and diesel(also called a compression-ignition engine).Both engines are called heat engines; the burning fuel generates heat which causes the gas inside the cylinder to increase its pressure and supply power to rotate a shaft connected to the transmission.

1.3 Body

An automobile body is a sheet metal shell with windows, doors, a hood, and a trunk deck built into it. It provides a protective covering for the engine, passengers, and cargo. The body is designed to keep passengers safe and comfortable. The body styling provides an attractive, colorful, modern appearance for the vehicle.

1.4 Chassis

The chassis is an assembly of those systems that are the major operating part of a vehicle. The chassis includes the transmission, suspension, steering, and brake systems.

Transmission systems — conveys the drive to the wheels. The main components are clutch, gearbox, driveshaft, final drive, and differential.

Suspension— absorbs the road shocks.

Steering— controls the direction of the movement.

Brake— slows down the vehicle.

1.5 Electrical Equipment

The electrical system supplies electricity for the ignition, horn, lights, heater, and starter. The electricity level is maintained by a charging circuit. This circuit consists of the battery, alternator (or generator). The battery stores electricity. The alternator changes the engine's mechanical energy into electrical energy and recharges the battery.

New Words

Principal component 主要部件
category 种类，类型
body 车身
chassis 底盘
layout 布置
power unit 动力装置
internal combustion engine 内燃机
cylinder 汽缸
gasoline 汽油
spark 火花
ignition 点燃，点火

diesel 柴油机
compression 压缩
shaft 轴
transmission 传动系
sheet metal 金属板
shell 外壳
hood （发动机）罩
trunk deck 行李舱盖
cargo 货物
styling 样式
assembly 总成，装配
suspension 悬挂，悬置
shock 冲击
steering 转向，操纵
brake 刹车，制动器
clutch 离合器
gearbox 变速器
driveshaft 传动轴
final drive 主减速器，后桥
differential 差速器
slow down （使）慢下来，减速
horn 喇叭
starter 起动机
charge 充电
alternator 交流发电机

Review Questions

1. List the main parts of an automobile?
2. What are the common types of a vehicle according to body styling?
3. Which systems does a chassis include and what are the main functions of the chassis?
4. Why are suspension systems used on vehicles?

CHAPTER2 INTERNAL COMBUSTION ENGINE

2.1 principle of operation

2.1.1 Engine and power

Engine is used to produce power. The chemical energy in fuel is converted to heat by the burning of the fuel at a controlled rate. This process is called combustion. If engine combustion occurs with the power chamber. ,the engine is called internal combustion engine. If combustion takes place outside the cylinder, the engine is called an external combustion engine.

Engine used in automobiles are internal combustion heat engines. Heat energy released in the combustion chamber raises the temperature of the combustion gases with the chamber. The increase in gas temperature causes the pressure of the gases to increase. The pressure developed within the combustion chamber is applied to the head of a piston to produce a usable mechanical force, which is then converted into useful mechanical power.

2.1.2 Engine Terms

Linking the piston by a connecting rod to a crankshaft causes the gas to rotate the shaft through half a turn. The power stroke “uses up” the gas , so means must be provided to expel the burnt gas and recharge the cylinder with a fresh petrol-air mixture :this control of gas movement is the duty of the valves ;an inlet valve allows the new mixture to enter at the right time and an exhaust valve lets out the burnt gas after the gas has done its job. Engine terms are :

TDC(Top Dead Center):the position of the crank and piston when the piston is farther away from the crankshaft.

BDC(Bottom Dead Center):the position of the crank and piston when the piston is nearest to the crankshaft.

Stroke : the distance between BDC and TDC; stroke is controlled by the crankshaft.

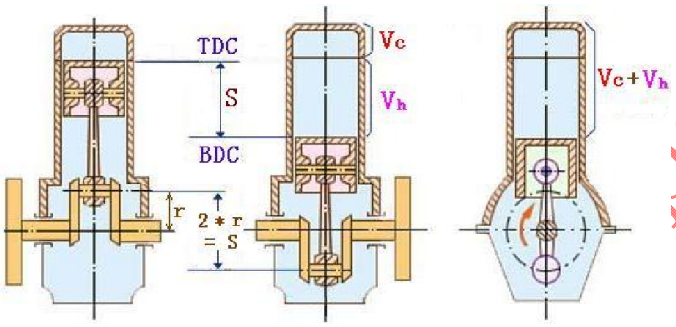
Bore : the internal diameter of the cylinder.

Swept volume : the volume between TDC and BDC.

Engine capacity : this is the swept volume of all the cylinder e.g. a four-stroke having a capacity of two liters(2000cm) has a cylinder swept volume of 50cm.

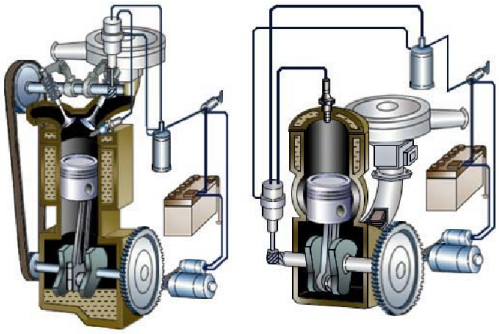
Clearance volume: the volume of the space above the piston when it is at TDC.

Compression ratio = (swept vol + clearance vol)\(clearance vol)



Two-stroke : a power stroke every revolution of the crank.

Four-stroke : a power stroke every other revolution of the crank..

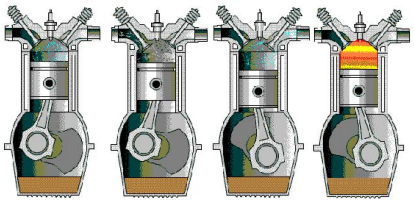


2.1.3 The Four-stroke Spark-ignition Engine Cycle

The spark-ignition engine is an internal-combustion engine with externally supplied in ignition , which converts the energy contained in the fuel to kinetic energy.

The cycle of operations is spread over four piston strokes. To complete the full cycle it takes two revolutions of the crankshaft.

The operating strokes are **:**



This stroke introduces a mixture of atomized gasoline and air into the cylinder. The stroke starts when the piston moves downward from a position near the top of the cylinder. As the piston moves downward, a vacuum, or low-pressure area, is created.

During the intake stroke, one of the ports is opened by moving the inlet valve. The exhaust valve remains tightly closed.

Compression stroke

As the piston moves upward to compress the fuel mixture trapped in the cylinder, the valves are closed tightly. This compression action heats the air/fuel mixture slightly and confines it within a small area called the combustion chamber.

Power stroke

Just before the piston reaches the top of its compression stroke, an electrical spark is introduced from a spark plug screwed into the cylinder head.

The spark ignites the compressed, heated mixture of fuel and air in the combustion chamber to cause rapid burning. The burning fuel produces intense heat that causes rapid expansion of the gases compressed within the cylinder. This pressure forces the piston downward. The downward stroke turns the crankshaft with great force.

Exhaust stroke

Just before the bottom of the power stroke, the exhaust valve opens. This allows the piston, as it moves upward, to push the hot, burned gases out through the open exhaust valve.

Then, just before the piston reaches its highest point, the exhaust valve closes and the inlet valve opens. As the piston reaches the highest point in the cylinder, known as TDC, it starts back down again. Thus, one cycle ends and another begins immediately.

2.1.4 Engine Overall Mechanics

The engine has hundreds of other parts . The major parts of engine are engine block , engine heads, pistons, connecting rods, crankshaft and valves. The other parts are joined to make systems. These systems are the fuel system, intake system, ignition system, cooling system, lubrication system and exhaust system. Each of these systems has a definite function. These systems will discussed in detail later.

NEW WORD

Piston	活塞
Connecting rod	连杆
Crankshaft	曲轴
Power stoke	活塞行程

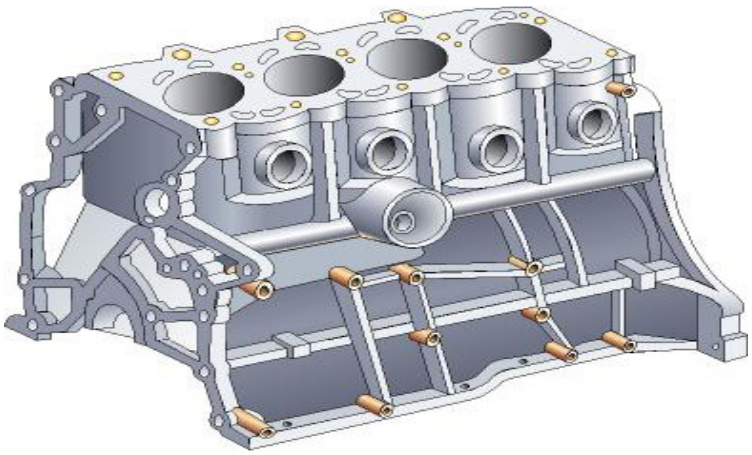
Expel	排出
Valve	气阀
inlet(intake) valve	进气阀
exhaust valve	排气阀
term	术语
TDC	上止点
BDC	下止点
Bore	缸径
swept volume	有效容积
engine capacity	发动机排量
clearance volume	余隙容积,燃烧室容积
compression ratio	压缩比
revolution	旋转,转数
every other	每隔一个
cycle	循环
spread over	分布,遍及
intake stroke	进气行程
compression stroke	压缩行程
knock	敲缸,敲打
exhaust stroke	排气行程
engine block	发动机缸体
lubrication	润滑

2.2 Engine Block and Cylinder Head

2.2.1 Engine Block

The engine block is the basic frame of the engine. All other engine parts either fit inside it or fasten to it. It holds the cylinders, water jackets, and oil galleries. The engine block also holds the crankshaft, which fastens to the bottom of the block. The camshaft also fits inside the block, except on overhead-cam engines (OHC). In most cars, this block is made of gray iron, or an alloy (mixture) of gray iron and other metals, such as nickel or chromium. Engine blocks are castings.

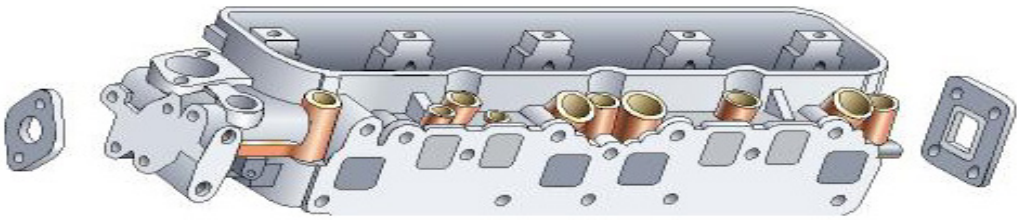
Some engine blocks, especially those in smaller cars, are made of cast aluminum. This metal is much lighter than iron. However, iron wears better than aluminum. Therefore, the cylinders in most aluminum engines are lined with iron or steel sleeves. These sleeves are called cylinder sleeves. Some engine blocks are made entirely of aluminum.



汽缸体

2.2.2 Cylinder Head

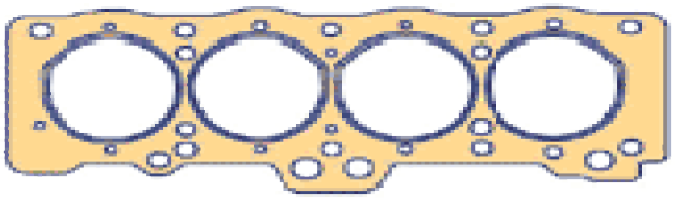
The cylinder head fastens to the top of the block, just as a roof fits over a house. The underside forms the combustion chamber with the top of the piston. The most common cylinder head types are the hemi, wedge, and semi-hemi. All three of these terms refer to the shape of the engine's combustion chamber. The cylinder head carries the valves, valve springs and the rockers on the rocker shaft, this part of the valve gear being worked by the push-rods. Sometimes the camshaft is fitted directly into the cylinder head and operates on the valves without rockers. This is called an overhead camshaft arrangement. Like the cylinder block, the head is made from either cast iron or aluminum alloy.



汽缸盖

2.2.3 Gasket

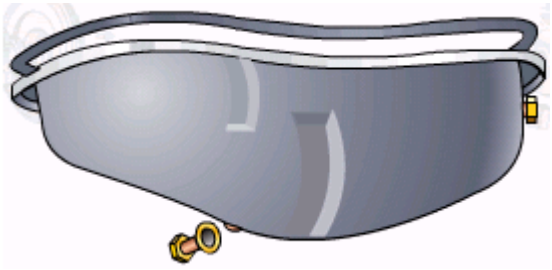
The cylinder head is attached to the block with high-tensile steel studs. The joint between the block and the head must be gas-tight so that none of the burning mixture can escape. This is achieved by using cylinder head gasket. This is a sandwich gasket, i.e. a sheet of asbestos between two sheets of copper, both these materials being able to withstand the high temperature and pressures within the engine.



汽缸垫

2.2.4 Oil Pan or Sump

The oil pan is usually formed of pressed steel. The oil pan and the lower part of the cylinder block together are called the crankcase; they enclose, or encase, the crankshaft. The oil pump in the lubricating system draws oil from the oil pan and sends it to all working parts in the engine. The oil drains off and runs down into the pan. Thus, there is constant circulation of oil between the pan and the working parts of the engine.



New Words

engine block 缸体
cylinder head 气缸盖
fasten 使固定
water jacket 水套
oil gallery 油道
camshaft 凸轮轴
overhead-cam(OHC) 顶置凸轮
gray iron 灰铸铁
alloy 合金
nickel 镍
chromium 铬
casting 铸件
head cover 汽缸盖罩
intake manifold 进气总管
distributor 分电器
oil pan 油底壳
aluminum 铝
be lined with 镶有
cylinder sleeve 气缸套
hemi 半球形
wedge 楔型，楔入
semi-hemi 准半球形
rocker 摇臂
push-rod 推杆
gasket 衬垫
high-tensile 高强度的
stud 螺栓
gas-tight 密封的
asbestos 石棉
crankcase 曲轴箱，曲柄箱

encase 封闭，把…包起来

drain off 排出，流出

Review Question

1. What do TDC, BDC, stroke, compression ratio and engine capacity stand for?
2. How do you calculate swept volume and compression ratio?
3. What controls the length of the stroke?
4. List the main parts of the engine overall mechanics?
5. What are the main function of the engine block?

2.3 Piston Connecting Rod and Crankshaft

2.3.1 Piston Assembly

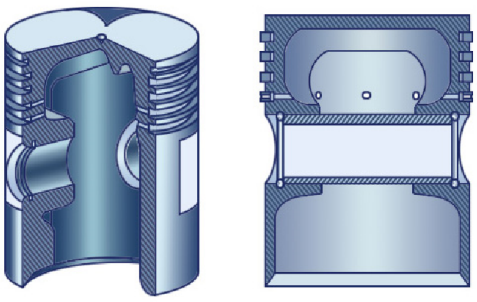
The piston is an important part of a four-stroke cycle engine. Most pistons are made from cast aluminum. The piston , through the connecting rod, transfers to the crankshaft the force create by the burning fuel mixture. This force turns the crankshaft .Thin, circular , steel bands fit into grooves around the piston to seal the bottom of the combustion chamber. These bands are called piston rings. The grooves into which they fit are called ring grooves. A piston pin fits into a round hole in the piston . The piston pin joins the piston to the connecting rod . The thick part of the piston that holds the piston is the pin boss.

The piston itself , its rings and the piston pin are together called the piston assembly.

2.3.2.Piston

To withstand the heat of the combustion chamber, the piston must be strong. It also must be light, since it travels at high speeds as it moves up and down inside the cylinder. The piston is hollow. It is thick at the top where it take the brunt of the heat and the expansion force. It is thin at the bottom, where there is less heat. The top part of the piston is the head , or crown . The thin part is the skirt The sections between the ring grooves are called ring lands.

The piston crown may be flat , concave ,dome or recessed . In diesel engine , the combustion chamber may be formed totally or in part in the piston crown , depending on the method of injection . So they use pistons with different shapes.



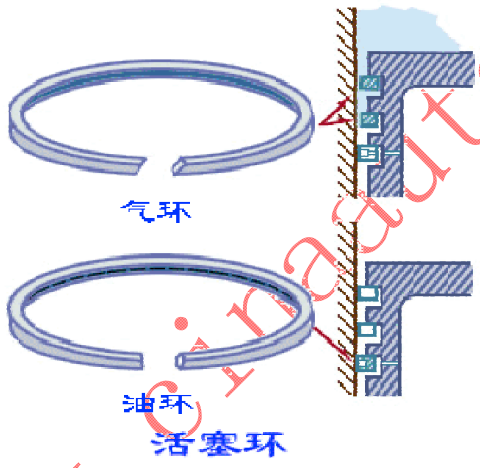
活 塞

2.3.3Piston Rings

As Fig.2-9 shows , piston rings fit into ring grooves near the of the piston. In simplest terms, piston rings are thin, circular pieces of metal that fit into grooves in the tops of the pistons.

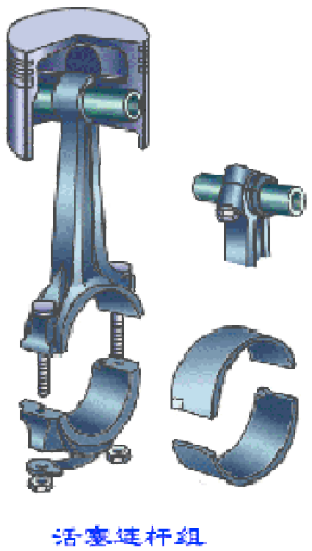
In modern engines ,each piston has three rings. (Piston in older engines sometimes had four rings, or even five.) The ring's outside surface presses against the cylinder walls. Rings provide the needed seal between the piston and the cylinder walls. That is, only the rings contact the cylinder walls. The top two rings are to keep the gases in the cylinder and are called compression rings. The lower one prevents the oil splashed onto the cylinder bore from entering the combustion chamber , and is called an oil ring. Chrome-face cast-iron compression rings are commonly used in automobile engines. The chrome face provide a very smooth , wear-resistant surface.

During the power stoke , combustion pressure on the combustion rings is very high. It causes them to untwist . Some of the high-pressure gas gets in back of the rings. This force the ring face into full contact with the cylinder wall. The combustion pressure also holds the bottom of the ring tightly against the bottom of the ring groove. Therefore , high combustion pressure causes a tighter seal between the ring face and the cylinder wall.



2.3.4 Piston Pin

The piston pin holds together the piston and the connecting rod . This pin fits into the piston pin holes and into a hole in the top end of the connecting rod. The top end of is much smaller than the end that fits on the crankshaft . This small end fits inside the bottom of the piston . The piston pin fits through one side of the piston , through the small end of the rod , and then through the other side of the piston . It holds the rod firmly in place in the center of the piston. Pins are made of high-strengh steel and have a hollow center . Many pins are chrome-plated to help them wear better.



2.3.3 Connecting rod

The connecting rod is made of forged

high-strength steel . It transmits and motion from the piston to the crankpin on the crankshaft . The connecting rod little end is connected to the piston pin . A bush made from a soft metal , such as bronze , is used for this joint . The lower end of the connecting rod fits the crankshaft journal . This is called the big end . For this big-end bearing , steel-backed lead or tin shell bearing are used . These are the same as those used for the main bearings . The split of the big end is sometimes at an angle , so that it is small enough to be withdrawn through the cylinder bore . The connecting rod is made from forged alloy steel .

2.3.5 Crankshaft

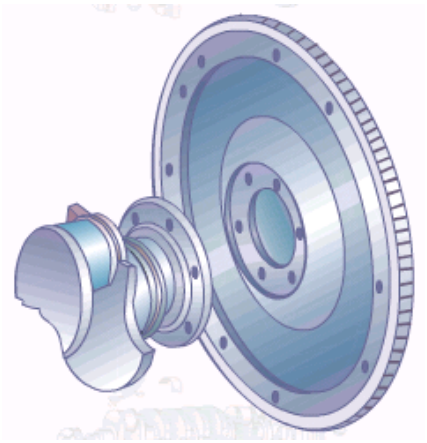
The crankshaft , in conjunction with the connecting rod , coverts the reciprocating motion of the piston to the rotary motion needed to drive the vehicle . It is usually made from carbon steel which is alloyed with a small proportion of nickel .The main bearing journals fit into the cylinder block and the big end journals align with the connecting rods .At the rear end of the crankshaft is attached the flywheel , and at the front end are the driving whells for the timing gears , fan , cooling water and alternator .

The throw of the crankshaft , the distance between the main journal and the big end centers , controls the length of the stroke . The stroke is double the throw , and the stroke-length is the distance that the piston travels from TDC to BDC and vice versa .

曲轴

2.3.6 Flywheel

The flywheel is the made from carbon steel . It fit s onto the rear of the crankshaft . As well as keeping the engine rotating between power strokes it also carries the clutch , which transmits the drive to the transmission , and has the starter ring gear around its circumference . There is only one working stroke in four so a flywheel is needed to drive the crankshaft during the time that the engine is performing the non-power strokes .



New Words

Comprise 由。。。。。。组成，包含
Inter 惯性，惯量
Radius 半径，范围
Circular 圆形的
Steel band 钢圈
Fit into 放入，放进
Groove 凹槽
Piston pin 活塞销
Pin boss 活塞销凸台
Withstand 抵抗
Hollow 空的
Brunt 冲力
Crown 活塞顶
Skirt 裙部
Ring land 环带
Concave 凹的，凹入的
Dome 圆顶
Recessed 隐蔽的
Cylinder wall 气缸壁
Cylinder bore 缸筒
Splash 飞溅
chrome-face 表面镀银的
Untwist 朝相反方向的
In place 在适当位置
Chrome-plated 镀铬的
Forge 伪造，仿造
Crankpin 曲轴销
Bush 轴瓦，套筒
Bronze 青铜
Crankshaft journal 曲轴轴颈
Steel-backed 钢背的
Lead 铅

Tin 锡
Splint 切口，中断，分配，分离
In conjunction with 连同
Reciprocating motion 往复运动
Rotary 旋转的
Carbon steel 碳钢
Journal 轴颈
Align with 匹配
Overlap 重叠
Timing gear 正时齿轮
Throw 摆幅
Vice verse 反之亦然
Impulse 脉冲
Space out 隔开，分隔
Through out 遍及
Diagram 图表
Firing order 点火顺序
Companion 成对
Circumference 圆周

2.4 Valve System

The valve system is made up of those parts needed to open and close the valves at just the right time .

2.4.1 Valve Operation

To coordinate the four-stroke cycle , a group parts called the valve train opens and closes the valves (moves them down and up , respectively) . These valve movements must take place at exactly the right moments . The opening of each valve is controlled by a camshaft .

1. Camshaft(OHC) Valve Train Overhead

The cam is an egg-shaped piece of metal on a shaft that rotates in coordination with the crankshaft . The metal shaft , called the camshaft , typically has individual cams for each valve in the engine . As the camshaft rotates , the lobe , or high spot of the cam , pushes against parts connected to the stem of the valve . This action forces the valve to move downward . This action could open an inlet valve , or open an exhaust valve for an exhaust stroke .

As the camshaft continues to rotate , the high spot moves away from the valve mechanism . As this occurs , valve spring pull the valve tightly closed against its opening , called the valve seat .

Valve in modern car engines are located in the cylinder head at the top the engine . This is known as an overhead valve (OHC) configuration . In addition , when the camshaft is located over the cylinder head , the arrangement is known as overhead camshaft (OHC) design . Some high-performance engine have two separate camshafts , one for each set of inlet and exhaust valves . These engines are known as overhead-camshaft (DHOC) engine .

2. Push-rod Valve Train

The camshaft also can be located in the lower part of the engine , within the engine block . To transfer the motion of the cam upward to the valve , additional parts are needs .

In this arrangement , the cam lobs push against round metal cylinders called follower

upward (away from the camshaft) . The cam follower rides against a push rod , which pushes against a rocker arm . The rocker arm pivots on a shaft through its center . As one side of the rocker arm moves up , the other side moves down , just like a seesaw . The downward-moving side of the rocker arm pushes on the valve stem to open the valve .

Because a push-rod valve train has additional parts , it is more difficult to run at high speeds . Push-rod engines typically run at slower speeds and , consequently , produce less horsepower than overhead-camshaft designs of equal size . (Remember , power is the rate at which work is done .)

2.4.2 Valve Clearance

When the engine runs in compression stroke and power stroke , the valves must close tightly on their seats to produce a gas-tight seal and thus prevent the gases escaping from the combustion chamber . If the valves do not close fully the engine will not develop fill power . Also the valve heads will be liable to be brunt by the passing hot gases , and there is the likelihood of crown touching an open valve , which can seriously damage the engine .

So that the valves can close fully some clearance is needed in the operating mechanism . This means that the operating mechanism must be able to move sufficiently far enough away from the valve t allow the valves to be fully closed against its seat by the valve spring . However , if the clearance is set too great this will cause a light metallic taping noise .

2.4.3 Valve Timing

The time at which valves open and close (valve timing) and the duration of the valve opening in stated in degrees of crankshaft rotation . For example , the intake valve normally begins to open just before the piston has reached the top dead center . The valve remains open as the piston travels down to BDC and even past BDC . This is intake valve duration .An example of this could be stated as follows : IO at 17BTDC , IC at 51ABDC (or , intake opens 17before top dead center , intake closes 51after bottom dead center) . Intake valve duration in this case is 248 of crankshaft rotation .

This leaves 129 duration for the compression stroke since compression ends when the piston reaches TDC . At this point the power stroke begins . The power stroke ends when the exhaust valve begins to open approximately at 51 before bottom dead center . The duration of the power stroke in this case is also 129 .

Since the exhaust valve is opening at 51 BBDC , this begins the exhaust stroke . The exhaust stroke continues as the piston passes BDC and moves upward to past TDC . With the exhaust valve closing at 17 TTDC , the duration of the exhaust stroke is 248 .

It is apparent from this description that the exhaust valve stays open for a short period of time during which the intake valve is also open . In other words , the end of the exhaust stroke and the beginning of the intake stroke overlap for a short period of time . This is called valve overlap . Valve timing and valve overlap vary on different engines.

Opening the intake valve before TDC and closing it after BDC increase the fill of air-fuel mixture in the cylinder . Opening the intake valve early helps overcome the static inertia of the air-fuel mixture at the beginning of the intake stroke , while leaving the intake valve open after BDC takes advantage of the kentia of the moving air-fuel mixture . This increase volumetric efficiency .

As the piston moves down on the power stroke past the 90 ATDC position , pressure in the cylinder has dropped , and the leverage to the crankshaft has decreased due to connecting rod

angle and crankshaft position . This ends the effective length of the power stroke , and the exhaust valve can now be opened to begin expelling the burned gases . The exhaust valve remains open until the piston has moved up past the TDC position . This helps to remove as much of the burned gases as is possible and increase volumetric efficiency .

2.4.4 Cam Design and Control Dynamics

The function of the cam is to open and close the valves as far as possible , as fast as possible and as smoothly as possible . The closing force for the valves is applied by the valve spring which also maintain contact between the cam and the valves . Dynamic force impose limits on cam and valve lift .

The entire valve-train assembly can be view as a spring \mass system in which the conversion from stored to free energy causes force vibration . Valve-train assemblies with overhead camshafts can be represented with sufficient accuracy by a 1-mass system (consisting of the moving mass , the valve-train assembly stiffness and corresponding damping) .

For system with valve bottom-mounted camshaft and push rods , a 2-mass system is being increasingly used .

The maximum permissible contact stress , usually regarded as the parameter which limits cam-lobe radius and the rate of opening on the flank , currently lies between 600-700Mpa depending upon the material parings used .

2.4.5 Camshaft Drive Mechanism

Each cam must revolve once during the four-stroke cycle to open a valve. A cycle, remember, corresponds with two revolutions of the crankshaft . Therefore, the camshaft must revolve at exactly half the speed of the crankshaft . This is accomplished with a 2:1 gear ratio .A gear connected to the camshaft has twice the number of teeth as a gear connected to the crankshaft. The gears are linked in one of three ways:

1.Belt Drive

A cog-type belt can be used . Such belts are made of synthetic rubber and reinforced with internal steel or fiberglass strands. The belts have teeth ,or slotted spaces to engage and drive teeth on gear wheels. A belt typically is used on engines with overhead-cam valve trains.

2.Chain Drive

On some engines, a metal chain is used to connect the crankshaft and camshaft gears. Most push-rod engines and some OHC engines have chains.

3.Gear Drive

The camshaft and crankshaft gears can be connected directly, or meshed. This type of operating linkage commonly is used on older six-cylinder, inline engines.

A camshaft driven by a chain or belt turns in the same direction as the crankshaft . But a Camshaft driven directly by the crankshaft gear turns in the opposite direction. Timing belts are used because they cost less than chains and operate more quietly. A typical timing belt is made of neoprene (synthetic rubber) reinforced with fiberglass.

2.4.6 Electronic Valve Control System

An electronic value control (EVC) system replaces the mechanical camshaft, controlling each value with actuators for independent value timing. The EVC system controls the opening and closing time and lift amount of each intake and exhaust valve with independent actuators on each value. Changing from a mechanical camshaft driven value into

independently controlled actuator valves provides a huge amount of flexibility in engine control strategy. Vehicles utilizing EVC can realize several benefits including:

1) increases engine power and fuel economy,
2) allows centralized and distributed EVC systems to perform at their full potential,
3) adapts to engines of varied cylinder counts.

With all of the improved efficiencies and consumer benefits, auto manufacturers are eager to get their first EVC systems on the road. The EVC system is targeted to operate in temperatures up to 125, while the actuator is targeted to run up to 6000 r/min. The actuator can be controlled in a centralized system with a high-speed multiplex bus (up to 10Mbps) or in a distributed system with a nominal speed bus.

EVC systems must be compact in size, specifically the actuators that must be small enough to fit in the engine space. A vehicle that uses a 42V system is ideal for EVC because it requires high voltage to control the value actuators, and EVC is targeted for V8 and V12 engines. The EVC system is also highly flexible, allowing adaptability for a number of cylinder engines.

New Words

coordinate	协调
valve train	气阀传动
respectively	分别的，各自的
overhead camshaft	顶置凸微轮轴
guide	导管
tappet	挺杆
valve insert	气门座
cotter	锁销，锁片
opening	口
lobe	凸起
spot	点，位置
stem	杆
dual	双的
cam follower	凸轮挺杆
seesaw	跷跷板，杠杆
value clearance	气门间歇
gas-tight seal	气封
liable to	容易
likelihood	可能
tapping	轻敲
valve timing	配气正时
intake valve	进气阀
exhaust valve	排气阀
static	静态的，静力的
kinetic	（运）动的，动力（学）的
volumetric	测定体积的
leverage	杠杆作用
offset	偏移量

dynamics	动力学
valve lift	气门挺杆
valve…as…	把…..看成……
parameter	参数，参量
radius	半径，范围
flank	侧面
pairing	配对，成对
correspond with	相当于
gear ratio	传动比
cog-type belt	齿型带
synthetic rubber	合成橡胶
reinforce	加强
fiberglass	玻璃纤维
strand	绳，线，绞合
slotted	有槽的，切槽的
mesh	相啮合
linkage	联动
inline engine	直列发动机
neoprene	氯丁（二稀）橡胶
electronic valve control (EVC)	电子式气阀控制
centralized system	集中系统
distributed system	分布系统
varied cylinder count	可变的汽缸数
architecture	结构，构造
processor	处理器
local node	局域节点
communication layer	通信层
synchronization	同步

Review Question

1. List the main parts of the OHC valve train .
2. How does a push-rod valve train work ?
3. how are the valve clearance adjusted by hand ?
4. Why do the intake valves open before TDC and close after BDC ?
5. What do we mean by “ valve overlap “
6. Why do most cars use timing belts rather than chains ?
7. What are the advantage of the electronic valve control (EVC) ?

2.5 Gasoline Fuel System

2.5.1 Gasoline

Gasoline is distilled from crude petroleum . Gasoline is highly flammable , meaning it burns easily in the presence of air .

Gasoline must vaporize easily . This characteristic , called volatility , is important . However , it must not vaporize too easily , or it will turn to vapor inside the fuel tank or fuel lines . Inside the

fuel line , fuel vapor may block the flow of liquid gasoline . This is called vapor lock . Vapor lock is common in fuel lines where the inlet side of the pump is exposed to high temperatures .

The flammability of gasoline varies with its quality and the additives mixed with the gasoline The way gasoline burns inside the combustion chamber is most important .

Increasing the pressure of the fuel mixture in the combustion chamber before ignition helps to increase the power of an engine . This is done by compression the fuel mixture to a smaller volume . Higher compression ratio not only boost power but also give more efficient power . But as the compression ratio goes up , knocking tendency increase . The octane number of a gasoline is a measure of its antiknock quality or ability to resist detonation during combustion . Detonation , sometimes referred to as knock , can be defined as an uncontrolled explosion of the last portion of the burning fuel-air mixture due to excessive temperature and pressure condition in the combustion chamber . Since detonation creates shock pressure waves , and hence audible knock , rather tan smooth combustion and expansion of the fuel-air mixture , it result in loss of power , excessive localized temperatures , and engine damage if sufficiently severe .

There are two commonly used methods of determining the octane number of motor gasoline the motor method and the research method . Both used the same type of laboratory single –cylinder engine , which is equipped with a variable head and a knock meter to indicate knock intensity . Using the test sample as fuel , the engine compression ratio and the air-fuel mixture are adjusted to develop a specified knock intensity . Two primary standard reference fuels , normal heptane and iso-octane , arbitrarily assigned 0 and 100 octane numbers , respectively , are then blended to produce the same knock intensity as the test sample . Thus , if the matching reference blend is made up of 15 n-heptane and 85 iso-octane , the test sample , the test sample is rate 85 motor or research octane number , according to the test method used .

2.5.2 Adaptation to Operating Condition

In certain operation conditions , the fuel requirement differs greatly from the basic injection-fuel quantity so that corrective is required in mixture formation .

1.Cold Start

During a cold start , the air-fuel mixture drawn in by the engine leans off . This is due to the low turbulence at cranking speeds causing poor mixture of the fuel particles with the air , and to the minimal evaporation of the fuel and wetting of the cylinder walls and intake ports with fuel at low temperature . In order to compensate for these phenomena , and thus facilitate staring of the cold engine , additional fuel must be injected during cranking .

2.Post-start Phase

After staring at low temperatures , it is necessary to enrich the mixture for a short period in order to compensate for poor mixture formation and wetting of the cylinder and intake-port walls with fuel . In addition , the rich mixture results in higher torque and therefore better throttle response when accelerating from idle .

3.Warm-up

The warm=up phase follows the cold-start and the post-start phase . The engine needs extra fuel during the warm-up phase because some of the fuel condenses on the still cold cylinder walls . At low temperatures , mixture formation is poor due to the large fuel droplets concerned , and due to the inefficient mixing of the fuel with the air drawn in by the engine , The result is that fuel condenses on the intake valves and in the intake manifold , and only evaporates at higher temperatures .

The above factors all necessitate an increasing enrichment of the mixture along with decreasing temperature .

4.Acceleration

If the throttle is opened abruptly , the air-fuel mixture is momentarily leaned-off , and a short period of mixture enrichment is needed to ensure good transitional response .

5 . Part Load

During part-load operation , achieving maximum air-fuel economy and observing the emission values are the crucial factors .

6.Full Load

The engine delivers maximum power at full load , when the air-fuel mixture must be enriched compared to that at part load .

This enrichment depends on engine speed and provide maximum possible torque over the entire engine-speed range . This also ensure optimum fuel-economy figures during full-load operation .

7.Idling

In addition to the efficiency of the engine , the engine idle speed principally determines the fuel consumption at idle .

The higher frictional resistances in the cold engine must be overcome by increasing the air-fuel mixture input . In order to achieve smoother running at idle , the idle-speed control increases the idle speed . This also leads to more rapid warm-up of the engine . Close-loop idle-speed control prevents too high an idle speed . The mixture quantity corresponds to the quantity required for maintaining the idle speed at the relevant load (e.g.. cold engine and increased friction) . It also permits constant exhaust-gas emission values for a long period without idle adjustment . Closed-loop idle-speed control also partially compensates for charges in the engine resulting from aging and ensures stable engine idling throughout the service life .

8.Overrun

Cutting off the fuel during deceleration reduces fuel consumption not merely on long downhill runs and during braking , but also in town traffic . Because no fuel is burnt , there are no emission .

9.Engine-speed Limiting

When a presser engine speed is reached , the ECU suppresses the fuel-injection pulses .

10.Adaptation of the Air-fuel Mixture at High Altitudes

The low density of air at high altitudes necessitates a leaner air-fuel mixture . At high altitudes , due to the lower air density , the volumetric floe measured by the air-fuel sensor corresponds to a lower air-mass floe . This error can compensated for by correcting the fuel quantity . Over-enrichment is avoided and , therefore , excessive fuel consumption .

2.5.3 Carburetor

As shown in Fig.2-20 , the fuel system has a fuel tank , fuel tank , fuel pump , fuel filter and carburetor . These parts store gasoline and deliver it to the carburetor as needed . Stated simply , the fuel tank stores the gasoline . The fuel lines carry the fuel from the tank to the carburetor . The fuel pump moves gasoline from the tank and through the fuel lines to carburetor . the fuel filter removes impurities from the gasoline . Then the carburetor sends the fuel — a mixture of air and gasoline — into the combustion chamber .

2.5.4 Motronic Combine Ignition and Fuel Injection System

The carburetor sends the correct air-fuel mixture to the engine . However , not all cars have carburetors . Fuel-injection systems are used on many modern cars .

Fuel-injection systems have many advantages over carburetors . For example , they provide more exact fuel control . Thus , they can better match air-fuel ratios to changing engine conditions . They also provide better economy and emission control . Furthermore , fuel-injection system do not need many of the parts that carburetor have .

The Motronic system is an engine-management system comprising a control unit (ECU) which implements at least the two basic function ignition and fuel injection , but which , however may contain additional subsystems as required for improves engine control .

1. Detection of Measured Valves

The combustion process in the cylinder is influenced not only by fuel management , mixture quantity and air-fuel ratio , but also by the ignition advance and the energy contained in the ignition spark . An optimized engine control the air-fuel ratio λ throughout the injection time t (i.e. the quantity of injected fuel) as well as the ignition advance angle α and the dwell angle β . The main parameters which effect the combustion process are detected as measure values and processed together such that the optimum ignition and injection timing is calculated for instantaneous engine operating conditions

2. Actuating Variables/Sensors

Engine speed and load are the main actuating variables . Because a specific ignition advance angle and a specific injection time correspond to each point of the engine speed/load map , it is important that all variables which pertain to the same point are calculate on the same speed /load area . This is only possible if the ignition advance and the injection time are calculated with the same speed and load valves (engine speed detected only once with the same sensors) .

This avoids statistical errors which can result , for example , from tolerances of different load sensor devices . Whereas a slightly different allocation in the part-load rage normally only increases consumption or exhaust emission , at full load near the knock limit the susceptibility t engine knocking increase . Clear allocation of the ignition timing angle and the injection time is provide by Motronic Systems , even under conditions of dynamic engine operation .

3. Motronic System

The Motonic system comprise a series of subsystem , the two basic subsystem being ignition and fuel injection . The combined system is more flexible and can implement a greater number of functions than the corresponding individual system . An important feature of the Motronic system is its implementation of a large number of freely programmable maps as desired for most sub-functions .

The exhaust gas recirculation (EGR) function has not been used in Europe to date , and is therefore provide only as an alternative systems . The lambda control system can only be considered today if used in conjunction with an adaptive precontrol for reasons of reduced exhaust emissions .

The knock control is either connected to the Motronic system via a defined interface , or integrated into the system . This combination of subsystem makes sense a physical standpoint : it enables a basic system (ignition and fuel injection) with open-loop functional control in a management system .

The idle speed control is realized by means of data from the ignition system and the fuel

emissions .

The knock control is either connected to the Motronic system via a defined interface , or integrated into the system . This combination of subsystem makes sense a physical standpoint : it enables a basic system (ignition and fuel injection) with open-loop functional control in a management system .

The idle speed control is realized by means of data from the ignition system and the fuel injection system and is part of the overall system of control which includes tank ventilation and camshaft control .

Microcomputer-controlled systems today are required to perform self-diagnosis of the control unit itself , as well as of the entire system to a certain extent . Motronic system of the future will thus include a diagnostic feature .

An engine-management system should include at least those function described here . The addition of other functions is practical if they can be implemented without the need for a number of additional inputs and outputs . System which use input and output signals different from those used by the Motronic system are not integrated but rather are connected with the Motronic system via interfaces . Typical examples of such systems are the transmission control system and the traction control system which access the ignition and injection system via corresponding interfaces .

4. System Configuration

Fig 2-22 is a typical Motronic system which shows the fuel circuit and the acquisition of load and temperature data . The system dose not include the cold-start valve or the thermo-time switch whose function are performed by the control unit . The auxiliary-air device has been replaced by the idle-speed actuator . In addition to the ignition coil , the ignition section also include the high-volt-age distributor which is normally mounted directly on the camshaft . In contrast to the conventional ignition distributor , the high-voltage distributor only incorporate the high-voltage distributor function . The control unit electronically determines the proper ignition timing as a function of engine speed and load .

5. Control Unit (ECU)

The ECU detects the instantaneous condition of the engine at very short intervals (milliseconds) via a number of sensors . The signals output by the sensors are fed to the ECU where input circuits remove any signal interference and convert the signals to a uniform voltage range . An A/D converter then transforms these signals to their signal equivalents . This information is then processed by the microcomputer , which generates output signals . The output stages amplify the low power lever of microcomputer outputs to the lever required by the actuators . All programs and maps are resident in a semiconductor memory . Digital signal level or component tolerance fluctuations . Digital accuracy is governed by word length , quartz-clock frequency constancy and the algorithms used for processing . Analog accuracy is determined by constancy and accuracy of the reference volt-ages , and by the components used in the input circuits . Program configuration must allow for the extreme real-time requirements of the engine : the interval between two ignition pulse in a 6-cylinder engine is only about 3ms at maximum speed . All essential calculation must be performed during this period . In addition to crankshaft-synchronous control processing , the ECU also has to calculate time-synchronous events .Both then functions have to wait if an interrupt occurs .

2.6 Engine Cooling

The purpose of the engine's cooling system is to remove excess heat from the engine , to keep the engine operation at its most efficient temperature , and to get the engine up to the correct temperature as soon as possible after staring .Ideally , the cooling system keeps the engine running at its most efficient temperature no matter what the operation are .

There are two types of cooling systems ; liquid cooling and air cooling . Most auto engines are cooled by the liquid type ; air cooling is used more frequently for airplanes , motorcycles and lawnmowers .

2.6.1 Liquid Cooling

This system consists of several interdependent parts that function together to maintain proper engine temperature . The cooling system of a water –cooled engine consists of the engine's water jacket , a thermostat , a water pump , radiator and radiator cap , a cooling fan (electric or belt-drive) , hoses , and usually an expansion (overflow) tank .

To dissipate excess engine heat , the cooling system performs four function :

1) absorption
2) circulation
3) radiation
4) control

Absorption occurs as coolant moves through the engine block . Heat energy from the burning fuel in the cylinders passes into the cylinder walls and cylinder head . Liquid coolant circulates through hollow spaces within the engine block and head to absorb the heat from the metal parts of the engine . The hollow spaces are known as the water jacket .

After absorbing the heat , the hot coolant passes out through the cylinder head and eaters the radiator . As the coolant circulates through the radiator , it gives up its heat to the metal tubes of the radiator . The radiator is made of brass or aluminum , metals that conduct heat well . As air passes through the radiator fins and around the tubes , heat is transferred to air .

However , if coolant circulated at all times from the engine to radiator , the engine would run very cool on cold days . Remember that chemical reaction , including the burning of the fuel , occur more efficiently at high temperature . Thus , for the engine to operate efficiently , there must be a control mechanism .

This control system is the thermostat . It regulates hoe much coolant is permitted to flow through the radiator . After you start the engine , it should heat an efficient operating temperature as quickly as possible and maintain that temperature without overheating .

2.7 Engine Lubrication

The purpose of the lubrication system is to circulate oil through the engine . An engine must have a good lubrication system . Without it , the friction heat from the contact of moving parts would wear the parts and cause power loss . Oil , when placed between two moving parts , separates them with a film . This oil film prevents the parts from rubbing against between each other . This oil film also cushions the parts , giving quieter and smoother engine operating .

Besides lubricating engine parts , oil is also used to :

1) clean the inside of the engine
2) help cool the engine
3) from a seal between the cylinder walls and piston rings .

Friction between engine components is reduced by :

1) boundary lubricating – relies on oil being splashed up onto the surfaces .
2) full film lubricating – an oil film is maintained by forcing the oil between the surfaces by an oil pump .

The system used on a modern engine combines both methods : pistons are lubricated by splash and bearing are pressure fed .

The main parts of a lubrication system are : pump , main oil gallery , relief valve and filters .

2.7.1 Pump

In most cars , the oil pump is in the crankcase above the sump . It draws oil through a tube that extends downward oil through a tube that extends downward into the sump .This tube has a filter screen over its bottom end . The screen keeps large pieces of sludge and dirt from being drawn into the pump . The tube may be hinged on the pump end so that it can move up and down as the oil level change in the sump . Thus , the pump always draws oil from the top of the sump , not from the bottom where the dirt and sludge tend to settle . Modern cars use one of two common types of oil pump – the gear – type and the rotor – type .

2.7.2 Main Oil Gallery and Relief Valve

This runs the length of the engine . Drilling from the gallery allow oil to be supplied to the bearing surfaces .

Generally fitted in the gallery , this spring loaded valves opens when the pressure reaches the maximum allowed .

2.7.3 Filters

Besides the gauze screen that prevents pieces of the metal entering the pump there is an external filter which can be renewed periodically . A modern engine uses a full – flow filtering system . In this system , the output of the oil pump flows through the oil filter before each trip through the engine . When an engine runs at 3000r/min its entire five quarts of oil pass through the filter at least once every minutes . Thus the oil filter ensures that only clean oil enters the engine .

New Words

Cushion 缓冲，减振
Relief valve 溢流阀
Sludge 油泥渣，残渣
Hinge 依。。。。。。而转移
Gauze screen filter 金属滤网滤清器

Review Question

1. What is the purpose of the cooling system ?
2. List the main parts a liquid – cooling system ?
3. Why is thermostat need is a liquid – cooling system ?
4. What are the main function of the lubrication system ?
5. List the main parts of the lubrication system ?

2.8 Exhaust System

The exhaust system carries exhaust gases from the engine's combustion chamber to the atmosphere and reduces , or muffles , engine noise . Exhaust gases leave the engine the engine in a pipe , traveling through a catalytic converter and a muffler before exiting through the tailpipe .

2.9.1 The Tailpipe

The tailpipe is a long metal tube attached to the muffler . It sticks out from under the body of a car , at the rear , in order to discharge the exhaust gases from the muffler of the engine into the air outside the car .

2.8.2 The Muffler

Exhaust gases leave the engine under extremely high pressure . If these gases escaped directly from the engine , the noise would be tremendous . For the reason , the exhaust manifold sends the gases to a muffler where they go through metal plates , or tubes , with a series of holes . The pressure of the gases is reduced when they pass through the muffler , so they go out of the tailpipe quietly .

The muffler is made of metal and is located underneath the body a car . it's connected between the tailpipe and the catalytic converter .

There are two types of muffler design . One type uses several baffled chambers to reduce noise . The other type sends the gases straight through perforate pipe wrapped in metal or fiberglass This type of muffler is designed for the purpose of reducing backpressure and , consequently , makes slightly more noise .

The muffler quests the noise of the exhaust by " muffling " the sound waves creates by the opening and closing of the exhaust valves . When an exhaust valve opens , it discharge the burned gases at high pressures into exhaust pipe , which is at low pressure . This type of action creates sound waves that travel through the flowing gas , moving much faster than the gas itself (up to 1400 m. p . h .) that the muffler must silence . It generally does this by converting the sound wave energy into heat by pasting the exhaust gas and through perforated chambers of varied sizes . Passing into the perforation and reflectors within the chamber forces the sound waves to dissipate their energy .

Car manufacturers are experimenting with an electronic muffler , which uses sensors to monitor the sound waves of the exhaust noise . The sound wave data are sent to a computer that controls speaker near the tailpipe . The system generates sound waves 180 degrees of phase with the engine noise . The sound waves from the electronic muffler collide with the exhaust sound waves and they cancel each other out , leaving only low – lever heat to emerge from the tailpipe .

2.8.3 The Exhaust Manifold And Header

The exhaust manifold , usually constructed of cast iron , is a pipe that conducts the exhaust gases from the combustion chambers to the exhaust pipe . It has smooth cures in it for improving the flow of exhaust .

The exhaust manifold is bolted to the cylinder head , and has entrances for the air that is injected into it . It is usually is located under the intake manifold .

A header is a different type of manifold , it is made of separate equal – length tubes .

2.8.4 Manifold to Exhaust Pipe Gasket

There are several types of that connect the exhaust pipe to manifold .

One is a flat surface gasket . Another type uses a ball and socket with spring to maintain pressure . This type allows some flexibility without breakage of the seal or the manifold . A third type is the full ball connector type , which also allows a little flexibility .

2.8.5 Exhaust Pipe Hangers

Hangers hold the exhaust system in place . They give the system flexibility and reduce the noise lever . The hanger system consists of rubber rings , tubes and clamps .

2.8.6 Exhaust pipe

The exhaust pipe is the bent – up or convoluted pipes underneath a car . Some are shaped to go over the rear axle allowing the rear axle to move up and down without bumping into the exhaust pipe ; some are shaped to bend around under the floor of the car , connecting the catalytic converter with the muffler . Exhaust pipes are usually made out of stainless steel , since the high heat conditions involved with the muffler system will cause rust .

2.8.7 Dual Exhaust System

The advantage of a dual exhaust system is that the engine exhausts more freely ,thereby lowering the backpressure , which is inherent in an exhaust system . With a dual exhaust system , a sizable increasing in engine horsepower can be obtained because the " breathing " capacity of the engine is improved , leaving less exhaust gases in the engine at the end of each exhaust stroke . This , in turn , leaves more room for en extra intake of the air – fuel mixture .

New Word

Tremendous 巨大的，极大的
Perforated 多孔的
Muffler 消音器
Tailpipe 尾管
Hanger 吊耳，吊钩
Manifold 歧管
Fiberglass 玻璃纤维
Speaker 扬声器
Header 集气管
Baffled 用挡板隔开的
Convoluted 回旋状的
Flat 平面
Sizable 相当大的，大小相当的
Room 空间
Bump 碰撞
Catalytic converter 催化转换器
Backpressure 背压

2.9The Ignition System

There are many different ignition systems . Most of these systems can be placed into one of three distinct : the conventional breaker point type ignition systems (in use since the early 1900s) ; the electronic ignition systems (popular since the mid 70s) ; and the distributorless ignition system (introduces in the mid 80s) .

The automotive ignition system has two basic functions ; it must control the spark and timing of the spark plug firing to match varying engine requirements , and it must increase battery voltage to a point where it will overcome the resistance offered by the spark plug gap and fire the plug .

2.9.1 Point – Type Ignition System

An automotive ignition system is divided into two electrical circuits – the primary and secondary circuits . The primary circuit carries low voltage . This circuit operates only on battery current and is controlled by the breaker points and the ignition switch . The secondary circuit coil (commonly called the coil wire) , the distributor cap the distributor rotor , the spark plug leads and the spark plugs .

The distributor is the controlling element of the system . It switches the primary current on and off and distributes the current to the proper spark plug each time a spark is needed . The distributor is a stationary housing surrounding a rotating shaft . The shaft is driven at one – half engine speed by the engine's camshaft through the distributor drive gears . A cam near the top of the distributor shaft has on lobe for each cylinder of the engine . The cam operates the contact points , which are mounted on a plate within the distributor housing .

A rotor is attached to the top of the distributor shaft . When the distributor cap is in place , a spring – loaded piece of metal in the center of the cap makes contact with a metal strip on top of the rotor . The outer end of the rotor passes very close to the contacts connected to the spark plug leads around the outside of the distributor cap .

The coil is the heart of the ignition system . Essentially , it is nothing more than a transformer which takes the relatively low voltage (12 volts) available from the battery and increasing it to a point where it will fire the plug as much as 40000 volts . The term "coil" is perhaps a misnomer since there are actually two coils of wire wound about an iron cone . These coils are insulated from each other and the whole assembly is enclosed in an oil – filled case . The primary coil , which consists of relatively few turns of heavy wire , is connected to the two primary terminals located on top of the coil . The secondary coil consists of many turns of fine wire. It is connected to the high – tension connection on top of the coil (the tower into which the coil wire from the distributor is plugged) .

Under normal operating conditions , power from the battery is fed through a resistor or resistance wire to the primary circuit of the coil and is then grounded through the ignition points in the distributor (the points are closed) . Energizing the coil primary circuit with battery voltage produces current flow through the primary winding , which induces a very large , intense magnetic filed . This magnetic filed remains as long as current flows and the points remain closed .

As the distributor cam rotates , the points are pushed apart , breaking the primary circuit and stopping the flow of current . Interrupting the flow of primary current causes the magnetic filed to collapse . Just as current flowing through a wire produces a magnetic filed , moving a magnetic filed across a wire will produce a current . As the magnetic filed collapses , its lines of wire in the secondary winding , inducing a current in them . Since there are many more turns of wire in the secondary windings , the voltage from the primary winding is magnified considerably up to 40000volts .

The voltage from the coil secondary winding flows through the coil high – tension lead to the center of the distributor cap , where it is distributed by the rotor to one of the outer terminals in the cap . From there , it flows through the spark plug lead to the spark plug . This process occurs in a split second and is repeated every time the points open and close , which is up to 1500 times a minute in a 4 – cylinder engine at idle .

2.9.2 Electronic Ignition Systems

The need for higher mileage , reduced emissions and greater reliability has led to the development of the electronic ignition system . These system generate a much stronger spark , which is needed to ignite leaner fuel Breaker point system needed a resistor to reduce the operating voltage of the primary circuit in order to prolong the life of the points . The primary circuit of the electronic ignition system operates on full battery voltage , which helps to develop a stronger spark . Spark plug gaps have winded due to the ability of the increased voltage to jump the large gap . Cleaner combustion and less deposits have led to longer spark plug life .

On some systems , the ignition coil has moved inside the distributor cap . This system is said to have an internal coil opposed to the complicated external .

Electronic ignition systems are not as complicated as they may first appear . In fact , they differ only slightly from conventional point ignition systems . Like conventional ignition systems , electronic systems have two circuits : a primary circuit and a secondary circuit . The entire secondary circuit is the same as in a conventional ignition system . In addition , the section of the primary circuit from the battery to the battery terminal at the coil is the same as in a conventional ignition system .

Electronic ignition system differ from conventional ignition system in the distributor component area . Instead of a distributor cam , breaker plate , points , and condenser , an electronic ignition system has an armature (called by various names such as a trigger wheel , redactor , etc .) , a pickup coil (stator , sensor , etc.) , and an electronic module .

2.9.3 Distributorless Ignition System (DIS)

The third type of ignition system is the distributorless ignition . The spark plugs are fired directly from the coils . The spark timing is controlled by an Ignition Control Unit (ICU) and the Engine Control Unit (ECU) . The distributorless ignition system may have one coil per cylinder , or one coil for each pair of cylinders .

Some popular systems use one ignition coil per two cylinders . This type of system is often known as the waste spark distribution method . In this system , each cylinder is paired with the cylinder opposite it in the firing order (usually 1 – 4 – 2 – 3 on 4 – cylinder engines or 1 – 4 – 2 – 5 – 3 – 6 on V6 engines) . The ends of each coil secondary leads are attached to spark plugs for the paired opposites . These two plugs are on companion cylinder , cylinders that are at Top Dead Center (TDC) at the sane time . But , they are paired opposites , because they are always at opposing ends of the 4 – stroke engine cycle . When one is at TDC of the compression stroke , the other is at TDC of the exhaust stroke . The one that is on compression is said to be the event cylinder and one on the exhaust stroke , the waste cylinder . When the coil discharges , both plugs fire at the same time to complete the series circuit .

Since the polarity of the primary and the secondary windings are fixed , one plug always fires in a forward direction and the other in reverse . This is different than a conventional system firing all plugs the same direction each time . Because of the demand for additional energy ; the coil design , saturation time and primary current flow are also different . This redesign of the system allows higher energy to be available from the distributorless coils , greater than 40 kilovolts at the rpm ranges .

The distributorless ignition system uses either a magnetic crankshaft sensor , camshaft position sensor , or both , to determine crankshaft position and engine speed . This signal is sent to the ignition control module or engine control module , which then energizes the appropriate coil .

The advantage of no distributor , in theory , is :

1. No timing adjustments .
2. No distributor cap and rotor .
3. No moving parts to wear out .
4. No distributor to accumulate moisture and cause staring problems .
5. No distributor to drive thus providing less engine drag .

The major components of a distributorless ignition are :

1. ECU or Engine Control Unit .

2. ICU or Ignition Control Unit .
3. Magnetic Triggering Device such as the Crankshaft Position Sensor and the Camshaft position Sensor .
4. Coil Pack .

New Words

Distributor 分电器
Condenser 电容器
Wear 磨损
Saturation 磁饱和
Series 串联
Wind 缠绕
Coil （ 点火 ）线圈
Transformer 变压器
Turn 匝数
Term 术语， 学期，条件
Breaker point type ignition system 触点型点火系统
Distributorless ignition system 无分电器点火系统
Primary and secondary circuits 初级和次级电路
Magnetic filed 磁场
High tension lead 高压导线
Distributor rotor 分火头
Spark plug 火花塞

Chaper3 Chassis

3.1clutch

The engine produces the power to drive the vehicle . The drive line or drive train transfer the power of the engine to the wheels . The drive train consists of the parts from the back of the flywheel to the wheels . These parts include the clutch , the transmission ,the drive shaft ,and the final drive assembly .

The clutch which includes the flywheel ,clutch disc , pressure plate , springs , pressure plate cover and the linkage necessary to operate the clutch is a rotating mechanism between the engine and the transmission . It operates through friction which comes from contact between the parts . That is the reason why the clutch is called a friction mechanism . After engagement, the clutch must continue to transmit all engine torque to transmission depending on the friction without slippage . The clutch is also used to disengage the engine from the drive train whenever the gears in the transmission are being shifted from gear ratio to another .

To start the engine or shift the gears , the driver has to depress the clutch pedal with the purpose of disengagement the transmission from the engine . At that time , the driven members connected to the transmission input shaft are either stationary or rotating at a speed that is slower of faster than the driving members connected to engine crankshaft . There is no spring pressure on the clutch assembly parts . So there is no friction between the driving members and driven members . As the driver lets loose the clutch pedal , spring pressure increase on the clutch parts . Friction between the parts also increases . The pressure exerted by the springs on the driven members is controlled by the driver through the clutch pedal and linkage . The positive

engagement of the driving and driven members is made possible the friction between the surfaces of the members . When full spring pressure is applied , the speed of the driving and driven members should be the same . At the moment , the clutch must act as a coupling device and transmit all engine power to the transmission , without slipping .

However , the transmission should be engaged to the engine gradually in order to operate the car smoothly and minimize torsional shock on the drive train because an engine at idle just develop little power . Otherwise , the driving members are connected with the driven members too quickly and the engine would be stalled .

The flywheel is a major part of the clutch . The flywheel mounts to the engine's crankshaft and transmits engine torque to the clutch assembly . The flywheel , when coupled with the clutch disc and pressure plate makes and breaks the flow of power the engine to the transmission .

The flywheel provides a mounting location for the clutch assembly as well . When the clutch is applied , the flywheel transfers engine torque to the clutch disc . Because of its weight , the flywheel helps to smooth engine operation . The flywheel also has a large ring gear at its outer edge , which engages with a pinion gear on the starter motor during engine cranking .

The clutch disc fits between the flywheel and the pressure plate . The clutch disc has a splined hub that fits over splines on the transmission input shaft . A splined hub has grooves that match splines on the shaft . These splines fit in the grooves . Thus , the two parts held together . However , back – and – forth movement of the disc on the shaft is possible . Attached to the input shaft , the disc turns at the speed of the shaft .

The clutch pressure plate is generally made of cast iron . It is round and about the same diameter as the clutch disc . One side of the pressure plate is machined smooth . This side will press the clutch disc facing are against the flywheel . The outer side has shapes to facilitate attachment of spring and release mechanism . The two primary types of pressure plate assemblies are coil spring assembly and diaphragm spring .

In a coil spring clutch the pressure plate is backed by a number of coil springs and housed with them in a pressed – steed cover bolted to the flywheel . The spring push against the cover . Neither the driven plate nor the pressure plate is connected rigidly to the flywheel and both can move either towards it o away . When the clutch pedal is depressed a thrust pad riding on a carbon or ball thrust bearing is forced towards the flywheel . Levers pivoted so that they engage with the thrust pad at one end and the pressure plate tat the other end pull the pressure plate back against its springs . This releases pressure on the driven plate disconnecting the gearbox from the engine .

Diaphragm spring pressure plate assemblies are widely used in most modern cars . The diaphragm spring is a single thin sheet of metal which yields when pressure is applied to it . When pressure is removed the metal spring back to its original shape . The center portion of the diaphragm spring is slit into numerous fingers that act as release levers . When the clutch assembly rotates with the engine these weights are flung outwards by centrifugal plate and cause the levers to press against the pressure plate . During disengagement of the clutch the fingers are moved forward by the release bearing . The spring pivots over the fulcrum ring and its outer rim moves away from the flywheel . The retracting spring pulls the pressure plate away from the clutch plate thus disengaging the clutch .

When engaged the release bearing and the fingers of the diaphragm spring move towards the transmission . As the diaphragm pivots over the pivot ring its outer rim forces the pressure plate against the clutch disc so that the clutch plate is engaged to flywheel .

The advantages of a diaphragm type pressure plate assembly are its compactness , lower weight , fewer moving parts , less effort to engage , reduces rotational imbalance by providing a balanced force around the pressure plate and less chances of clutch slippage .

The clutch pedal is connected to the disengagement mechanism either by a cable or , more commonly , by a hydraulic system . Either way , pushing the pedal down operates the disengagement mechanism which puts pressure on the fingers of the clutch diaphragm via a release bearing and causes the diaphragm to release the clutch plate . With a hydraulic mechanism , the clutch pedal arm operates a piston in the clutch master cylinder . This forces hydraulic fluid through a pipe to the cutch release cylinder where another operates the clutch disengagement mechanism by a cable .

The other parts including the clutch fork , release bearing , bell – housing , bell housing cover , and pilot bushing are needed to couple and uncouple the transmission . The clutch fork , which connects to the linkage , actually operates the clutch . The release bearing fits between the clutch fork and the pressure plate assembly . The bell housing covers the clutch assembly . The bell housing cover fastens to the bottom of the bell housing . This removable cover allows a mechanic to inspect the clutch without removing the transmission and bell housing . A pilot bushing fits into the back of the crankshaft and holds the transmission input shaft .

New Word

Clutch 离合器
Flywheel 飞轮
Stationary 静止的，不动的，不变的，固定的
Torsional 扭转的，扭力的
Crankshaft 曲轴，机轴
Stall 停止，停转，迟延
Mount 安放，设置，装上
Groove 凹槽，沟
Lever 杆，杠杆，控制杆
Pivot 支点
Gearbox 变速器
Retract 缩回，缩进，收回，
Compactness 紧密，简洁
Drive train 传动系
Drive shaft 传动轴
Pressure plate 压盘
Clutch disc 离合器从动盘，离合器摩擦片
Gear ratio 传动比
Release bearing 分离轴承
Release fork 分离拨叉
Master cylinder 主缸
Clutch pedal 离合器踏板
Coupling device 结合装置
At idle 空转。空闲
Couple with 与。。。。。。结合

Ring gear 外形齿轮，齿圈
Pinion gear 小齿轮
Splined hub 花键毂
Cast iron 铸铁
Diaphragm spring 膜片弹簧
Thrust pad 止推片
Engage with 结合
Centrifugal force 离心力
Fulcrum ring 支撑环
Pilot bushing 导轴衬
Bell housing 钟形外壳，离合器壳

3.2 AUTOMATIC TRANSMISSION

The modern automatic transmission is by far , the most complicated mechanical component in today's automobile . It is a type of transmission that sifts itself . A fluid coupling or torque converter is used instead of a manually operated clutch to connect the transmission to the engine .

There are two basic types of automatic transmission based on whether the vehicle is rear wheel drive or front wheel drive . On a rear wheel drive car , the transmission is usually mounted to the back of the engine and is located under the hump in the center of the floorboard alongside the gas pedal position . A drive shaft connects the transmission to the final drive which is located in the rear axle and is used to send power to the rear wheels . Power flow on this system is simple and straight forward going from the engine , through the torque converter , then trough the transmission and drive shaft until it reaches the final drive where it is split and sent to the two rear transmission .

On a front wheel drive car , the transmission is usually combined with the final drive to form what is called a transaxle . The engine on a front wheel drive car is usually mounted sideways in the car with the transaxle tucked under it on the side of the engine facing the rear of the car . Front axles are connected directly to the transaxle and provide power to front wheels . In this example , power floes from the engine , through the torque converter to a larger chain that sends the power through a 180 degree turn to the transmission that is along side the engine . From there , the power is routed through the transmission to the final drive where it is split and sent to the two front wheels through the drive axles .

There are a number of other arrangements including front drive vehicles where the engine is mounted front to back instead of sideways and there are other systems that drive all four wheels but the two systems described here are by far the most popular . A much less popular rear and is connected by a drive shaft to the torque converter which is still mounted on the engine . This system is found on the new Corvette and is used in order to balance the weight evenly between the front and rear wheels for improved performance and handling . Another rear drive system mounts everything , the engine , transmission and final drive in the rear . This rear engine arrangement is popular on the Porsche.

The modern automatic transmission consists of many components and systems that designed to work together in a symphony of planetary gear sets , the hydraulic system, seals and gaskets , the torque converter , the governor and the modulator or throttle cable and computer controls that has evolved over the years into what many mechanical inclined individuals consider to be an art from .

Here try to used simple , generic explanation where possible to describe these systems .

3.2.1 Planetary gear sets

Automatic transmission contain many gears in various combinations . In a manual transmission , gears slide along shafts as you move the shift lever from one position to another , engaging various sizes gears as required in order to provide the correct gear ratio . In an automatic transmission , how ever , the gears are never physically moved and are always engaged to the same gears . This is accomplished through the use of planetary gear sets .

The basic planetary gear set consists of a sun gear , a ring and two or more planet gears , all remaining in constant mesh . The planet gears are connected to each other through a common carrier which allows the gears to spin on shafts called “pinions” which are attached to the carrier .

One example of a way that this system can be used is by connecting the ring gear to the input shaft coming from the engine , connecting the planet carrier to the output shaft , and locking the sun gear so that it can’t move . In this scenario , when we turn the ring gear , the planets will “walk” along the sun gear (which is held stationary) causing the planet carrier to turn the output shaft in the same direction as the input shaft but at a slower speed causing gear reduction (similar to a car in first gear) .

If we unlock the sun gear and lock any two elements together , this will cause all three elements to turn at the same speed so that to output shaft will turn at the same rate of speed as the input shaft . This is like a car that is third or high gear . Another way we can use a planetary gear set is by locking the planet carrier from moving , then applying power to the ring gear which will cause the sun gear to turn in opposite direction giving us reverse gear .

The illustration in Figure shows how the simple system described above would look in an actual transmission . The input shaft is connected to the ring gear , the output shaft is connected to the planet carrier which is also connected to a “Multi-disk” clutch pack . The sun gear is connected to drum which is also connected to the other half of the clutch pack . Surrounding the outside of the drum is a band that can be tightened around the drum when required to prevent the drum with the attached sun gear from turning .

The clutch pack is used , in this instance , to lock the planet carrier with the sun gear forcing both to turn at the same speed . If both the clutch pack and the band were released , the system would be in neutral . Turning the input shaft would turn the planet gears against the sun gear , but since noting is holding the sun gear , it will just spin free and have no effect on the output shaft . To place the unit in first gear , the band is applied to hold the sun gear from moving . To shift from first to high gear , the band is released and the clutch is applied causing the output shaft to turn at the same speed as the input shaft .

Many more combinations are possible using two or more planetary sets connected in various way to provide the different forward speeds and reverse that are found in modern automatic transmission .

3.2.2 Clutch pack

A clutch pack consists of alternating disks that fit inside a clutch drum . Half of the disks are steel and have splines that fit into groves on the inside of the drum . The other half have a friction material bonded to their surface and have splines on the inside edge that fit groves on the outer surface of the adjoining hub . There is a piston inside the drum that is activated by oil pressure at the appropriate time to squeeze the clutch pack together so that the two components become

locked and turn as one .

3.2.3 One-way Clutch

A one-way clutch (also known as a “sprag” clutch) is a device that will allow a component such as ring gear to turn freely in one direction but not in the other . This effect is just like that bicycle , where the pedals will turn the wheel when pedaling forward , but will spin free when pedaling backward .

A common place where a one-way clutch is used is in first gear when the shifter is in the drive position . When you begin to accelerate from a stop , the transmission starts out in first gear . But have you ever noticed what happens if you release the gas while it is still in first gear ? The vehicle continues to coast as if you were in neutral . Now , shift into Low gear instead of Drive . When you let go of the gas in this case , you will feel the engine slow you down just like a standard shift car . The reason for this is that in Drive , one-way clutch is used whereas in Low , a clutch pack or a band is used .

3.2.4 Torque Converter

On automatic transmission , the torque converter takes the place of the clutch found on standard shift vehicles . It is there to allow the engine to continue running when the vehicle comes to a stop . The principle behind a torque converter is like taking a fan that is plugged into the wall and blowing air into another fan which is unplugged . If you grab the blade on the unplugged fan , you are able to hold it from turning but as soon as you let go , it will begin to speed up until it comes close to speed of the powered fan . The difference with a torque converter is that instead of using air it used oil or transmission fluid , to be more precise .

A torque converter is a lager doughnut shaped device that is mounted between the engine and the transmission . It consists of three internal elements that work together to transmit power to the transmission . The three elements of the torque converter are the pump , the Turbine , and the Stator . The pump is mounted directly to the torque housing which in turn is bolted directly to the engine’s crankshaft and turns at engine speed . The turbine is inside the housing and is connected directly to the input shaft of the transmission providing power to move the vehicle . The stator is mounted to a one-way clutch so that it can spin freely in one direction but not in the other . Each of the three elements has fins mounted in them to precisely direct the flow of oil through the converter .

With the engine running , transmission fluid is pulled into the pump section and is pushed outward by centrifugal force until it reaches the turbine section which stars it running . The fluid continues in a circular motion back towards the center of the turbine where it enters the stator . If the turbine is moving considerably slower than the pump , the fluid will make contact with the front of the stator fins which push the stator into the one way clutch and prevent it from turning . With the stator stopped , the fluid is directed by the stator fins to re-enter the pump at a “help” angle providing a torque increase . As the speed of the turbine catches up with the pump , the fluid starts hitting the stator blades on the back-side causing the stator to turn in the same direction as the pump and turbine . As the speed increase , all three elements begin to turn at approximately the same speed . Sine the ‘80s , in order to improve fuel economy , torque converters have been equipped with a lockup clutch which locks the turbine to the pump as the vehicle reaches approximately 40-50 mph . This lockup is controlled by computer and usually won’t engage unless the transmission is in 3rd or 4th gear .

3.2.5 Hydraulic System

The hydraulic system is a complex maze of passage and tubes that sends that sends transmission fluid and under pressure to all parts of the transmission and torque converter and . Transmission fluid serves a number of purpose including : shift control ,general lubrication and transmission cooling . Unlike the engine ,which uses oil primary for lubrication ,every aspect of a transmission ‘s function is dependant on a constant supply of fluid is send pressure . In order to keep the transmission at normal operating temperature , a portion of the fluid is send to through one of two steel tubes to a special chamber that is submerged in anti-freeze in the radiator . Fluid passing through this chamber is cooled and then returned to the transmission through the other steel tube . A typical transmission has an avenge of ten quarts of fluid between the transmission , torque converter , and cooler tank , In fact , most of the components of a transmission are constantly submerged in fluid including the clutch packs and bands . The friction surfaces on these parts are designed to operate properly only when they are submerged in oil .

3.2.6 Oil Pump

The transmission oil pump (not to confused with the pump element inside the torque converter) is responsible for producing all the oil pressure that is required in the transmission . The oil pump is mounted to front of the transmission case and is directly connected to a flange on the engine crankshaft , the pump will produce pressure whenever the engine is running as there is a sufficient amount of transmission fluid available . The oil enters the pump through a filter that is located at bottom of the transmission oil pan and travels up a pickup tube directly to the oil pump . The oil is then sent , under pressure to the pressure regulator , the valve body and the rest of the components , as required .

3.2.7 Valve Body

The valve body is the control center of the automatic transmission . It contains a maze of channels and passages that direct hydraulic fluid to the numerous valves which when activate the appropriate clutch pack of band servo to smoothly shift to the appropriate gear for each driving situation . Each of the many valves in the valve body has a specific purpose and is named for that function . For example the 2-3 shift valve activates the 2nd gear up-shift or the 3-2 shift timing valve which determines when a downshift should occur .

The most important valve and the one that you have direct control over is the manual valve. The manual valve is directly connected to the gear shift handle and covers and uncovers various passages depending on what position the gear shift is paced in . When you place the gear shift in Drive , for instance , the manual valve directs fluid to the clutch pack (s) that activates 1st gear . It also sets up to monitor vehicle speed and throttle position so that it can determine the optimal time and the force for the 1-2 shift . On computer controlled transmission , you will also have electrical solenoids that are mounted in the valve body to direct fluid to the appropriate clutch packs or bands under computer control to more precisely control shift points .

3.2.8 Computer Controls

The computer uses sensors on the engine and transmission to detect such things as throttle position , vehicle speed , engine speed , engine load , stop light switch position , etc . to control exact shift points as well as how soft or firm the shift should be . Some computerized transmission even learn your driving style and constantly adapt to it so that every shift is timed precisely when you would need it .

Because of computer controls , sports models are coming out with the ability to take manual

control of the transmission as through it were a stick shift lever through a special gate , then tapping it in one direction or the other in order to up-shift at will . The computer monitors this activity to make sure that the driver dose not select a gear that could over speed the engine and damage it .

Another advantage to these " smart" transmission is that they have a self diagnostic mode which can detect a problem early on and warn you with an indicator light on the dash . A technician can then plug test equipment in and retrieve a list of trouble codes that will help pinpoint where the problem is .

3.2.9 Seals and Gaskets

An automatic transmission has many seals and gaskets to control the flow of hydraulic fluid and to keep it from leaking out . There are two main external seals : the front seal and the rear seal . The front seal seals the point where the torque converter mounts to the transmission case . This seal allows fluid to freely move from the converter to the transmission but keeps the fluid from leaking out . The rear seal keeps fluid from leaking past the output shaft .

A seal is usually made of rubber (similar to the rubber in a windshield wiper blade) and is used to keep oil from leaking past a moving part such as a spinning shaft . In some cases , the rubber is assisted by a spring that holds he rubber in close contact with the spinning shaft .

A gasket is a type of seal used to seal two stationary parts that are fasted together . Some common gasket materials are : paper , cork , rubber , silicone and soft metal .

Aside from the main seals , there are also a number of other seals and gasket that vary from transmission to transmission . A common example is the rubber O-ring that seals the shaft for the shift control lever . This is the shaft that you move when you manipulate the gear shifter . Another example that is common to most transmission is the oil pan gasket . In fact , seals are required anywhere that a device needs to pass through the transmission case with each one being a potential source for leaks .

New Words

Hump 圆形隆起
Transaxle 变速器驱动桥
Tuck 把一端塞进
Gasket 垫圈
Governor 油压调节器
Modulator 调制器
Spline 花键
Bond 结合
Strap 带,皮带
Doughnut 圆环图
Stator 定子,固定片
Maze 曲径
Submerge 浸没,淹没
Quart 夸脱
Downshift 调低速档
Optimal 最佳的
Solenoid 螺线管
Retrieve 重新得到

Cork 塞住
Manipulate 操作,使用
Fluid coupling 液力偶合器
Torque converter 液力变矩器
Planetary converter 行星齿轮组
Throttle cable 节气门拉线
Ring gear 齿圈
High gear 高速档
Reverse gear 倒档
Sprag clutch 锲块式单向离合器
Centrifugal force 离心力
Gear up 促进
Stick shift 顶杆档
Vacuum hose 真空软管
Throttle valve 节气阀
Leak out 泄露
Windshield wiper 风窗玻璃刮水器

3.3 The Differential System

When a vehicle is cornered the inner wheel moves through a shorter distance than the outer wheel . This means that the inner wheel must slow down and the outer wheel must speed up . During this period it is desirable that each driving maintains its driving action . The differential performs these two tasks . The principle of the bevel type differential can be seen if the unit is considered as two discs and a lever .

When the vehicle is traveling straight , the lever will divide the diving force equally and both discs will move the same amount .

When the vehicle corners , the driving will still be divided equally but the inner disc will now move through a smaller distance ,this will cause the lever to pivot about its center which will prize forward the outer disc to give it a greater movement . This action shows that the torque applied to each driving wheel is always equal – hence the differential is sometimes called a torque equalizer .

New Word

Desirable 想知道的
Disc 盘片,轮盘,轮圈
Prize 撬动,推动
Equalizer 平衡装置

3.4 Brake System

The breaking system is the most important system in cars . If the brakes fail , the result can be disastrous . Brakes are actually energy conversion devices , which convert the kinetic energy (momentum) of the vehicle into thermal (heat) . When stepping on the brakes , the driver commands a stopping force ten times as powerful as the force that puts the car in motion . The braking system can exert thousands of pounds of pressure on each of the four brakes .

The brake system is composed of the following basic components : the “master cylinder” which is located under the hood , and is directly connected to the brake pedal , converts driver foot’s mechanical pressure into hydraulic pressure . Steel “brake lines” and flexible “brake hoses” connect the master cylinder to the “slave cylinders” located at each wheel . Brake fluid , specially

designed to work in extreme condition , fills the system . “Shoes” and “Pads” are pushed by the salve cylinders to contact the “drum” and “rotors” thus causing drag , which (hopefully) slows the car .

The typical brake system consists of disk brakes in front and either disk or drum brakes in the rear connected by a system of tubes and hoses that link the brake at each wheel to the master cylinder .

Stepping on the brake pedal , a plunger is actually been pushing against in the master cylinder which forces hydraulic oil (brake fluid) through a series of tubes and hoses to the braking unit at each wheel . Since hydraulic fluid (or any fluid for that matter) cannot be compressed , pushing fluid through a pipe is just like pushing a steel bar through pipe . Unlike a steel bar , however , fluid can be directed through many twists and turns on its way to its destination , arriving with the exact same motion and pressure that it started with . It is very important that the fluid is pure liquid and that there are no air bubbles in it . Air can compress , which causes a sponginess to the pedal and severely reduced braking efficiency . If air is suspected , then the system must be bled to remove the air . There are “bleeder screws” at each wheel and caliper for this purpose .

On a disk brakes , the fluid from the master cylinder is forced into a caliper where it pressure against a piston . The piton , in-turn , squeezes two brake pads against the disk (rotor) which is attached to the wheel , forcing it to slow down or stop . This process is similar to the wheel ,causing the wheel to stop . In either case , the friction surface of the pads on a disk brake system , on the shoes on a drum brake convert the forward motion of the vehicle into heat . Heat is what causes the friction surfaces (lining) of the pads and shoes to eventually wear out and require replacement .

Brake fluid is a special oil that has specifics properties . It is designed to withstand cold temperatures without thickening as well as very high temperatures without boiling . (If the brake fluid should boil , it will cause you to have a spongy pedal and the car will be hard to stop) .

The brake fluid reservoir is on top of the master cylinder . Most cars today have a transparent reservoir so that you can see the level without opening the cover . The brake fluid lever will drop slightly as the brake pads wear . This is a normal condition and no cause for concern . If the lever drops noticeably over a short period of time or goes down to about two thirds full , have your brakes checked as soon as possible . Keep the reservoir covered expect for the amount of time you need to fill it and never leave a can of brake fluid uncovered . Brake fluid must maintain a very high boiling point . Exposure to air will cause the fluid to absorb moisture which will lower that boiling point .

The brake fluid travels from the master cylinder to the wheels through a series of steel tubes and reinforced rubber hoses . Rubber hoses are only used in places that require flexibility , such as at the front wheels , which move up and down as well as steer . The rest of the system uses non-corrosive seamless steel tubing with special fittings at attachment points . If a steel line requires a repair , the best procedure is to replace the complete line . If this is nit practical , a line can be repaired using special splice fittings that are made for brake system repair . You must never use brass “compression” fittings or copper tubing repair a brake system . They are dangerous and illegal .

3.4.1 Other Components in the Hydraulic System

Proportioning Valve or Equalizer Valve

These valves are mounted between the master cylinder and the rear wheels . They are designed

to adjust the pressure between the front and the rear brakes depending on how hard you are stopping . The shorter you stop , the more of the vehicle's weight is transferred to the front wheels , in some cases , causing the rear to lift and the front to dive . These valves are designed to direct more pressure to the front and less pressure to the harder you stop . This minimizes the chance of premature lockup at the rear wheels .

Pressure Differential Valve

This valve is usually mounted just below the master and is responsible for turning the brake warning light on when it detects a malfunction . It measures the pressure from the two sections of the master cylinder and compares them . Since it is mounted ahead of the proportioning or equalizer valve , the two pressure it detects should be equal . If it detects a difference , it means that there is probably a brake fluid leak somewhere in the system .

Combination Valve

The Combination valve is simply a proportioning valve and a pressure differential valve that is combine into one unit .

The parking brake system controls the rear brakes through a series of steel cables that are connected to either a hand lever or a foot pedal . The ideal is that the system is fully mechanical and completely bypasses the hydraulic system so that the vehicle can be brought to a stop even if there is a total brake failure .

New Word

Disastrous 灾难性的
Hood 发动机罩
Plunger 活塞,柱塞
Sponginess 轻软有弹性的
Malfunction 故障
Bypass 设旁路,与会
Corkscrew 活塞推杆
Inoperative 不起作用的
Booster 调压器,助力器
Slam 砰地踏下
Screech 发出尖锐的声音
Thumping 极大的
Momentarily 即刻
Thermal energy 热能
Master cylinder 制动主缸
Brake pedal 制动踏板
Brake hose 制动软管
Salve cylinder 轮缸
Drum brake 鼓式制动器
Brake shoe 制动蹄
Bleeder screw 放气螺钉
Spongy pedal 踏板发软
Panic stop 紧急停车,紧急制动
Friction lining 摩擦衬片
Proportioning valve 比列阀

Equalizer valve 平衡阀
Pressure differential valve 差压阀
Combination valve 组合阀

3.5 Steering System

3.5.1 Basic Parts of Steering System

The steering converts the steering –wheel rotary motion into a turn motion of the steered wheels of the vehicle .

The basic steering system in most cars is the same . The steering gear of steering box is the heart of the steering system .This is usually next to the engine . A shaft extends from the back of the steering gear . This shaft is connected to the steering column or steering shaft . The steering wheel is at the top of the steering column . Another shaft comes from the bottom of the steering gear . This shaft connects to the arms , rods , and links . This parts assembly , called the steering linkage , connects the steering gear to the parts at the wheels . The wheels and tires mount to the steering knuckles , As shown in fig , the knuckles are pivoted at the top and bottom . Thus , the wheels and rites can turn from side top side .

While the steering system may look complicated , it works quite simply . When a driver drives a car straight down the road , the steering gear is centered . The gear holds the linkage centered so that the wheels and tires point straight ahead . When the driver turns the steering wheel , the steering shaft rotates and the steering gear moves toward that side . The shaft coming out the bottom of the steering gear turns , as well . When the shaft turns , it pulls the linkage to one side and makes the steering knuckles turn slightly about their pivot points . Thus , the steering knuckle , spindle , wheels , and tires turn to one side , causing the car to turn .

The type of steering layout depends on the suspension system . The beam axle used on heavy commercial vehicle has a king pin fitted at each end of the axle and this pin is the pivot which allows the wheels to be steered . Cars have independent suspension and this system has ball joints to allow for wheel movement .

New Word

Steering box 转向器
Steering column 转向柱管
Steering linkage 转向传动机构
Steering knuckle 转向节
King pin 主销
Track rod 转向杆
Drop arm 摇臂
Stub axle 转向轴
Turn about 绕…….转动
Spindle 转向节(轴端)
Swivel joint 转向节

Types of Steering System

A steering box must have the following qualities :

1) no play in the straight-ahead position
2)low friction , resulting in high efficiency
3)high rigidity ,
4 readjustability

For these reasons , these are several different types of steering gears . However , there are only two types of steering systems : manual steering systems and power steering systems . In the manual type , the driver dose all the work of turning the steering wheel , steering gear , wheels and tires . In the power , hydraulic fluid assists the operation so that driver effort is reduced .

On today's cars , two types of steering systems commonly are used to provide steering control :

1) recirculating ball

2) rack and pinion

Either of these two types of steering mechanisms may be a fully mechanical systems or a power –assisted system .

3.6 Front Suspension

The front suspension is more complicated than the rear suspension . This is because the front wheels must move in several different directions . The wheels must move up and down with the suspension and turn left to right with the steering . Since the car goes in the direction in which the front wheels point , the alignment of the front wheels is important . The wheels must point in just the right direction for the car to move straight down the road and turn properly .

Modern cars uses an independent front suspension . In this system , each wheel mounts separately to the frame and has its own individual spring and shock absorber . Thus , the wheels act independently of one another . When one wheel hits a bump or hole in the road , the other wheel dose no9t deflect .

3.6.1 Front Wheel Alignment

As a car moves down the high-way , the suspension moves the front wheels up and down . At the same time , the steering mechanism moves the front wheels , sometimes to make turns and sometimes to make the travel straight . The angular relationship between the wheels and suspension parts during this motion is the front-end geometry . Since the geometry can change the alignment of front wheels is adjustable . You can change the adjustment to compensate for spring sag .

The alignment of the front wheels affects the operation of a car . Poor alignment ca make a car pull to one side and stop the front wheels from returning to the straight-ahead position after a turn . The three normally adjustable angles are caster , camber , and toe .

1. Toe-in

Toe-in specifies the degree to which non-parallel front wheels are closer together at the front than at the rear , measured at the edges of the rims at the wheel center height . front non-driven wheels , toe-in is approximately 2-3 mm , and between +3mm and-2 mm for driven wheels . Toe-in reduces the tendency of the wheels to shimmy .

2. Kingpin Angle

The kingpin angle is the inclination of the steering axis relative to the longitudinal plane , measured in the transverse plane of the vehicle . Kingpin angle is 2° -16° and determines the steering aligning torque in conjunction with steering offset and wheel caster . It is measured only with the vehicle loaded .

3. Camber

Camber is the inward or outward tilt of the wheel at the top . Inward tilt is negative camber and outward tilt is positive camber . The tilt of the wheel is measured inn degrees and is adjustable on many vehicles .

4. Caster

Caster is the forward or backward of spindle or steering the knuckle at the top when viewed from the side . Forward tilt is negative caster and backward tilt positive caster . Caster is measured in the number of degrees that it is forward or backward from true vertical and is adjustable on many vehicle .

New Word

Front wheel alignment 前轮定位
Sag 倾斜
Caster 主销倾角
Camber 车轮倾角
Toe 轮胎缘距
Toe-in 轮胎前束
Kingpin 主销
Align 矫正,对准
Positive camber 车轮外倾角
Negative camber 车轮内倾角
Deviate 偏离
Positive caster 主销正倾角
Negative caster 主销负倾角

3.6.2 Rear Suspension

The purpose of the rear suspension is to support the weight of the rear of the vehicle . As with the front suspension , this system contributes to the stability and ride of the vehicle . Rear suspension may be of the solid axle or independent design . Many cars have solid axle rear suspension . Either design may have different kinds of springs , including torsion bars . However , the coil spring and leaf spring types are most popular .

3.7 Wheels and Tires

To maintain grip when a vehicle is traveling at speed over a bumpy surface , a wheel must be light in weight . Also it must be strong , cheap to produce , easy to clan and simple to remove .

3.7.1. Wheels

The structure of the wheel is shown in Fig . The rim is made in one piece , with the wheel center welded or riveted to it . Most modern vehicles use the drop center type . This drop center provides a well for tire bead to drop into for tire removal . A slight hump at the head ledge holds the tire in place should it go flat while driving .

3.7.2. tires

Tires are important to your safety and comfort . They transmit the driving and braking power to the road . The car's directional control , road-ability and riding comfort are greatly dependent on the tires . Tires should be selected and maintained with great care .

There are two basic types of tires – those with inner tubes and those without (called "tubeless" tires) . Most modern automobile tires are of the tubeless type . Truck and bus tire are usually of the tube type .

Tires are made of several layers of nylon , rayon , or polyester fabric bonded together with belts of rayon , fiberglass , or steel cord . The rubber used in tires is a blend of natural and synthetic rubber .

New Words

Rim 轮缘

Bead 胎边,轮缘
Hump 凸起
Inner tube 内胎
Rayon 人造丝
Polyester 多元脂
Casing plies 帘布层
Rubber chafer 橡胶胎圈