Indian Institute of Technology Kanpur

National Programme on Technology Enhanced Learning (NPTEL)

Course Title
Aircraft Maintenance (Engines)

Lecture – 03
Construction of Reciprocating Engine

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Hello, so far we have seen the different types of reciprocating engines, the theory involved in the study of these engines the different cycles. In this video we are going to see the construction of the reciprocating engines, the different parts of the reciprocating engines.

So let us see about the different parts of the reciprocating engine.
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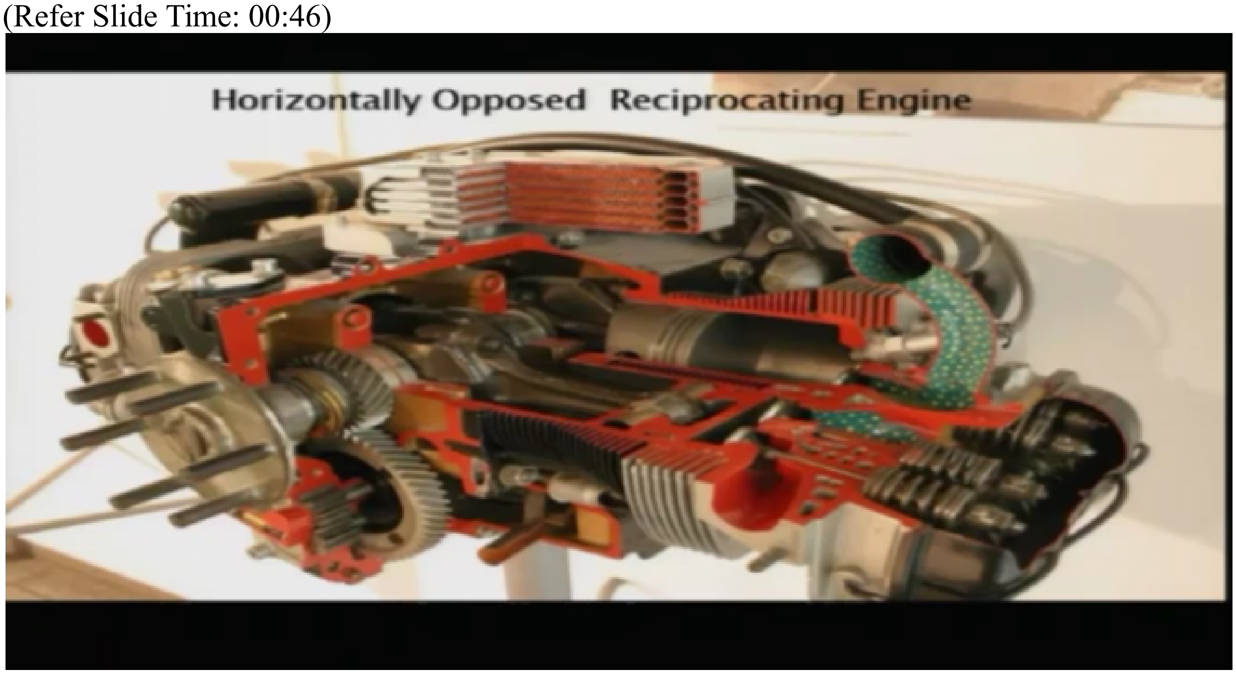

Here in this figure you can see horizontally opposed reciprocating engine, you can see the different parts of a reciprocating engine, this is a cutaway diagram giving you a cut view diagram. In the center you can see a crankshaft, here you can see a cylinder, this is the cylinder with a piston the connecting rods and the valves, the valves springs this is a diagram which gives you a basic view of a reciprocating engine.

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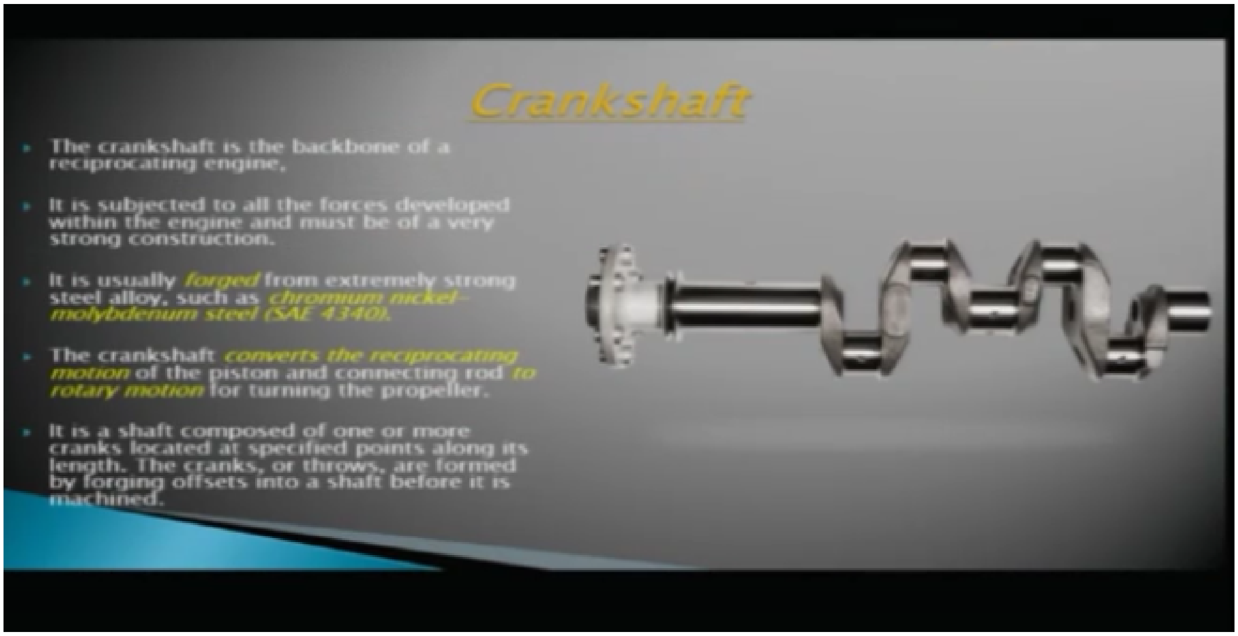

Coming to the different parts, the first part is the crankshaft here in the diagram you can see the crankshaft it is the backbone of a reciprocating engine which is subjected to all the forces developed within the engine and it must be of a very strong construction, since the crankshaft is exposed to lot of forces which are developed within the engine so it needs to be of a very strong construction, it is generally made of strong stream steel alloy such as chromium, nickel, molybdenum steel also numbered as SAE4340 and it is a forged construction.

So generally the crankshaft is a forging made of extremely strong steel alloy of chromium nickel molybdenum steel, we call it as CNM steel SAE4340, the basic purpose of the crankshaft is to convert the reciprocating motion of the piston and connecting rod to rotary motion for turning the propeller, so the crankshaft is basically converting the reciprocating motion of the piston and connecting rod to the rotary motion for turning the propeller, so it is a shift composed of one or more cranks located at specified points along its length, so you can see the crankshaft this is the central part and on both sides of the central section you can see the throws, the cranks, these are called the cranks or throws they are formed by forging offsets into a shaft before it is machine, so crankshaft it is a shaft composed of one or more cranks located at specified points along its length, so these are your cranks or we can call it a throw also, so this is your crank or throw, and they are formed at specified points along the length, they are formed by forging offsets into a shaft before it is machined.

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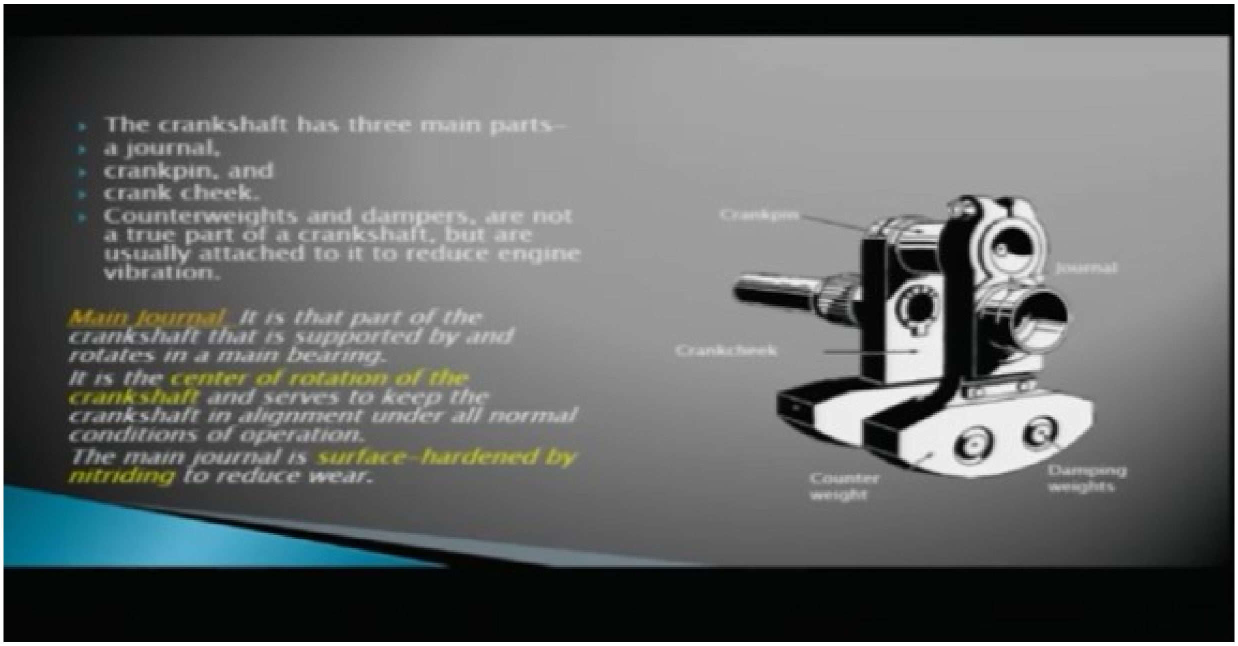

The crank shaft has three main parts it has a journal, a crankpin, this is your journal here, then the crankpin and a crank cheek, counterweights and dampers are also employed in some of the crankshafts they are not a true part of the crankshaft but are usually attached to it to reduce engine vibration, so you have seen the crankshaft has got three parts the main journal, the crankpin and the crank cheek.

The main journal it has that part of the crankshaft that is supported by and rotates in a main bearing, so main journal is the central part of the crankshaft, that part of the crankshaft which is supported in the main bearing and rotates in the main bearing, it is the center of rotation of the crankshaft and serves to keep the crank shaft in alignment under all normal conditions of operation.

The main journal it is surface hardened by nitriding to reduce wear, so you can see the main journal it is surface hardened by nitriding to reduce wear. In the previous diagram also you can see here the main journals, the main journals they are supported in the main bearing and rotate in the main bearing and they are the center of rotation of the crankshaft, and they keep the crankshaft in alignment under all normal conditions of operation, the main journal is surface hardened by nitriding to reduce wear.
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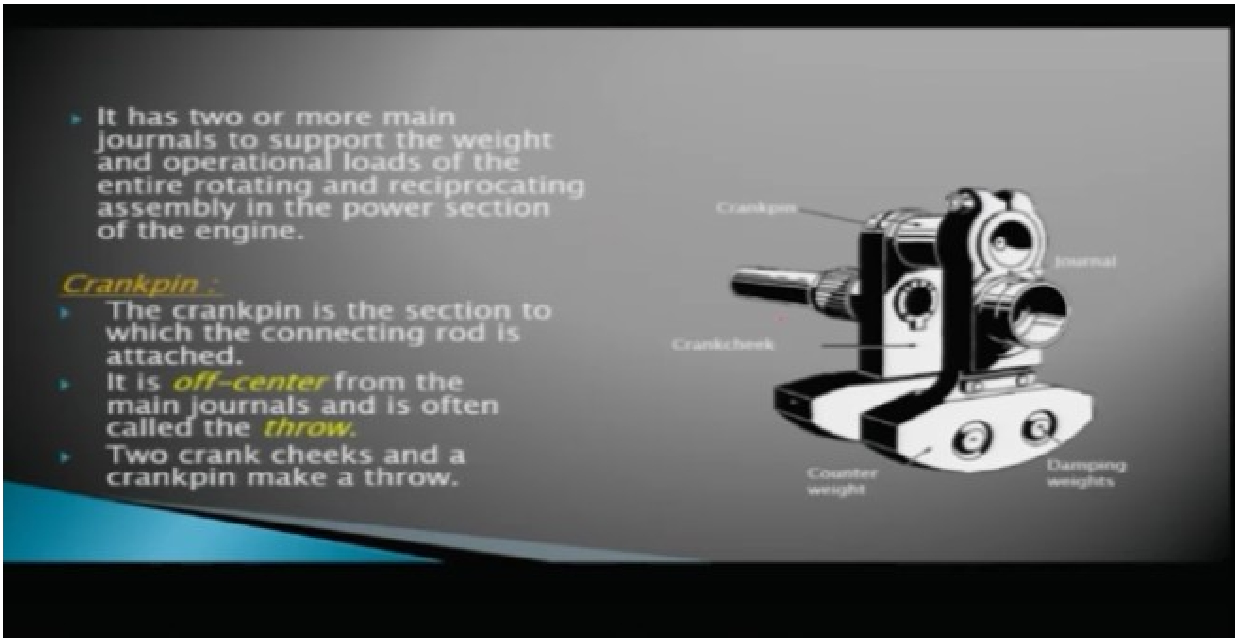

The journals maybe two or more to support the weight and operational loads of the entire rotating and reciprocating assembly in the power section of the engine, so in the crankshaft you can have two or more main journals to support the weight and operational loads of the entire rotating assembly.

Coming to crankpin, this is your crankpin you can see this is your crankpin,
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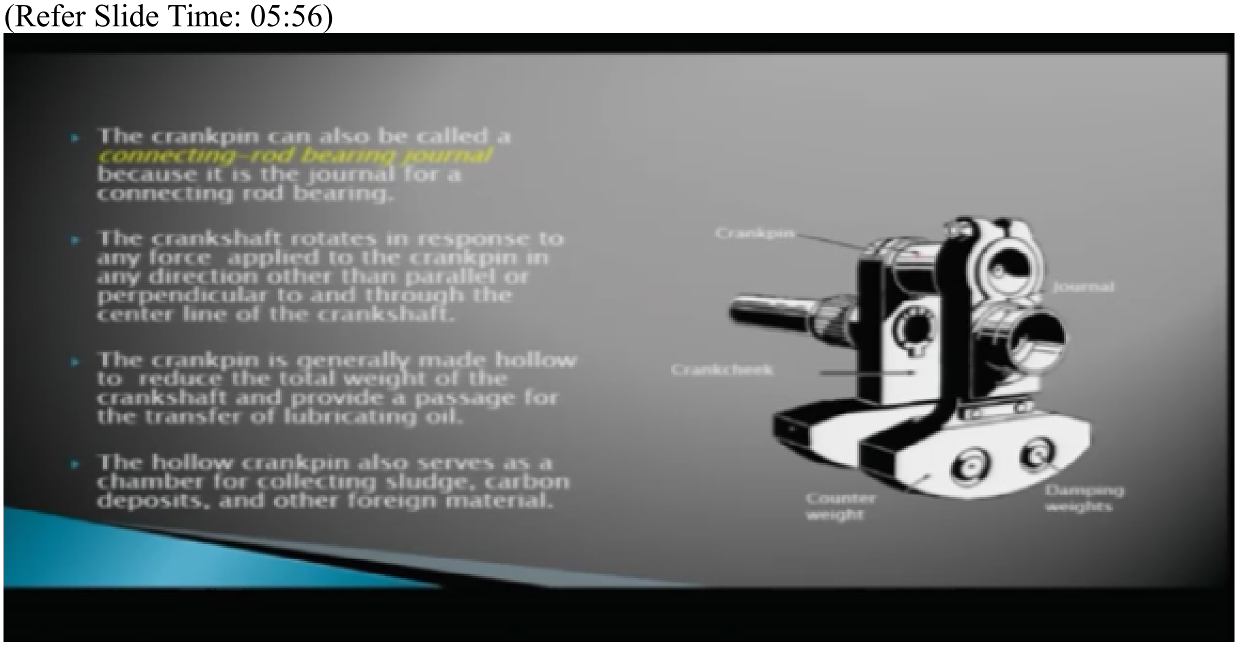

it is the section in which the connecting rod is attached so you have the connecting rod which is attached on the crankpin, it is off-center from the main journal, here is your main journal so this crankpin is off-center from the main general and is often called the throw, this is often called the throw.

Two crank cheeks and a crankpin make a throw, here this is your crank cheek so two crank cheeks and a crankpin, this is one crank cheek, and this is another crank cheek and this is a crankpin, two crank cheeks and a crankpin together make a throw, so this crankpin this is also called a connecting rod bearing journal, because a connecting rod is attached to the crankpin, so one end of the connecting rod is attached to the crankpin and the other end is connected to the crankshaft, one end of the connecting rod is attached to the crankpin and the other end is connected to the piston, so this crankpin is also called a connecting rod bearing journal because it is the journal for a connecting rod bearing.

The crankshaft rotates in response to any force applied to the crankpin in any direction, so any force which is applied to the crankpin in any direction other than parallel or perpendicular to and through the centerline of the crankshaft, so any force applied to the crankpin rotates the crankshaft, any force other than parallel to or perpendicular to through the centerline of the crankshaft.

The crankpin is generally made hollow, this crankpin is generally made hollow to reduce the total weight of the crankshaft and provides a passage for the transfer of lubricating oil, so in order to reduce the weight of the crankshaft the crankpins are made hollow to reduce the weight, and it also provides a passage for the transfer of lubricating oil.

The hollow crankpin also serves as a chamber for collecting sludge, carbon deposits, and other foreign material, so this crankpin this is a hollow crankpin this also serves as a chamber for collecting sludge material, carbon deposits, and other foreign material.

So we have seen in this figure this is your crankpin, this is your crank cheek, this is your crank cheek, and this is your journal, so two crank cheeks and a crankpin make a throw. The crankpins are generally hollow to collect foreign material, sludge, and carbon deposits and also provides a passage for the lubricating oil, the connecting rod is attached to the crankpin, one end of the connecting rod is attached to the crankpin, end of the connecting rod is attached to the piston, so any force which is applied to the crankpin, any force other than the parallel or perpendicular to the center line of the crankshaft, any force other than the parallel or perpendicular force makes the crankshaft rotate.
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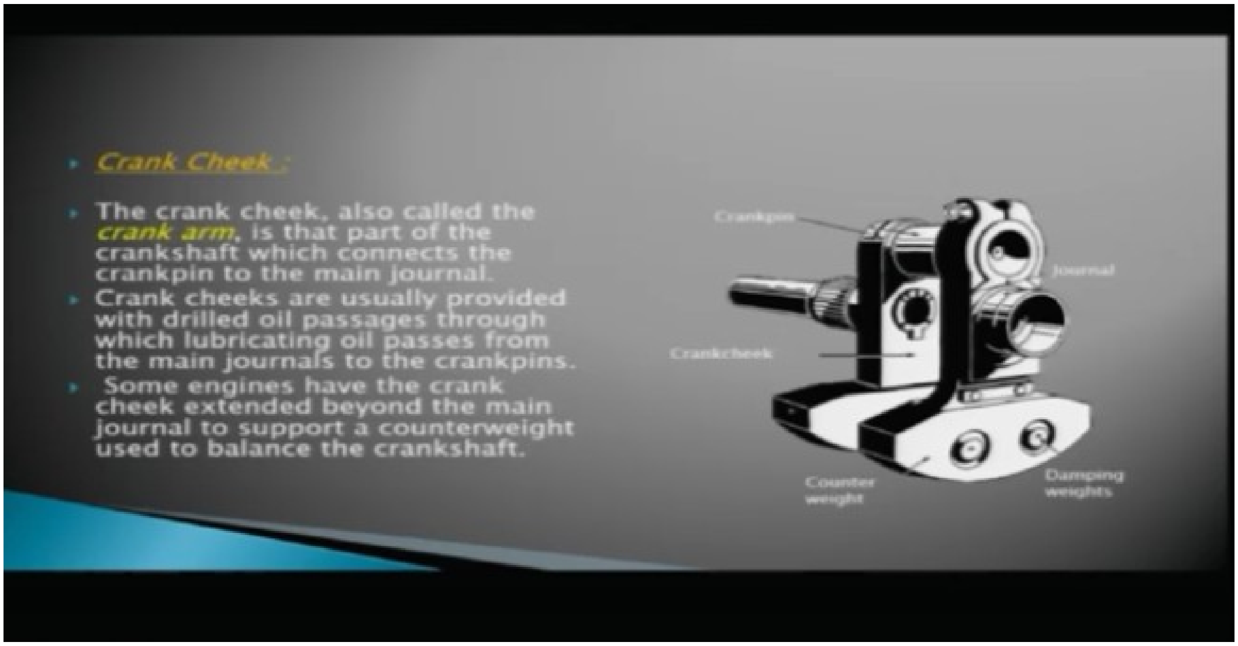

Coming to crank cheeks as we have seen this is the crank cheek, the crank cheek they are also called the crank arms is that part of the crankshaft which connects a crankpin to the main journal, so the crank cheek connects the crankpin to the main journal.

Crank cheeks are usually provided with drilled oil passages through which lubricating oil passes from the main journals to the crankpins. The crank cheeks also have passages in sight for the lubricating oil to transfer from the main journal to the crankpin, some engines have crank cheeks extended beyond the main journal to support a counterweight used to balance the crank shaft, so some crankshafts have their crank cheeks extended beyond the main journal so that they can accommodate counterweights, you can see here the counterweights they are meant to balance the crankshaft.

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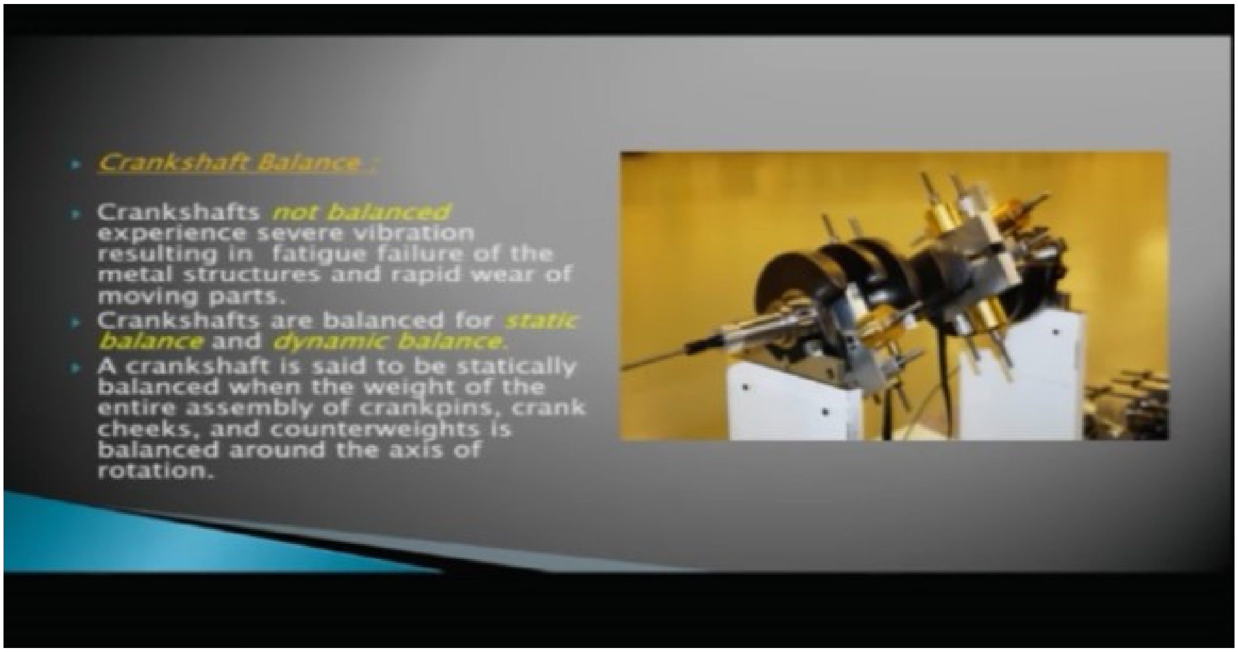

Crankshaft balancing, crankshafts which are not balanced experience severe vibration resulting in fatigue failure of the metal structures and rapid wear of the moving parts, so crankshafts which are not balanced will experience severe vibration which will result in fatigue failure of metallic structures and also rapid wear of the moving parts.

Crankshafts are supposed to be balanced statically and dynamically, a crankshaft is said to be statically balanced when the weight of the entire assembly of the crankpins, crank cheeks, and counterweights is balanced around the axis of rotation, so crankshaft is said to be statically balanced when the complete weight of the crankpin, crank cheeks, counterweights is balanced around the axis of rotation. The crankshaft is placed on two knife edges in order to test it for static balancing,

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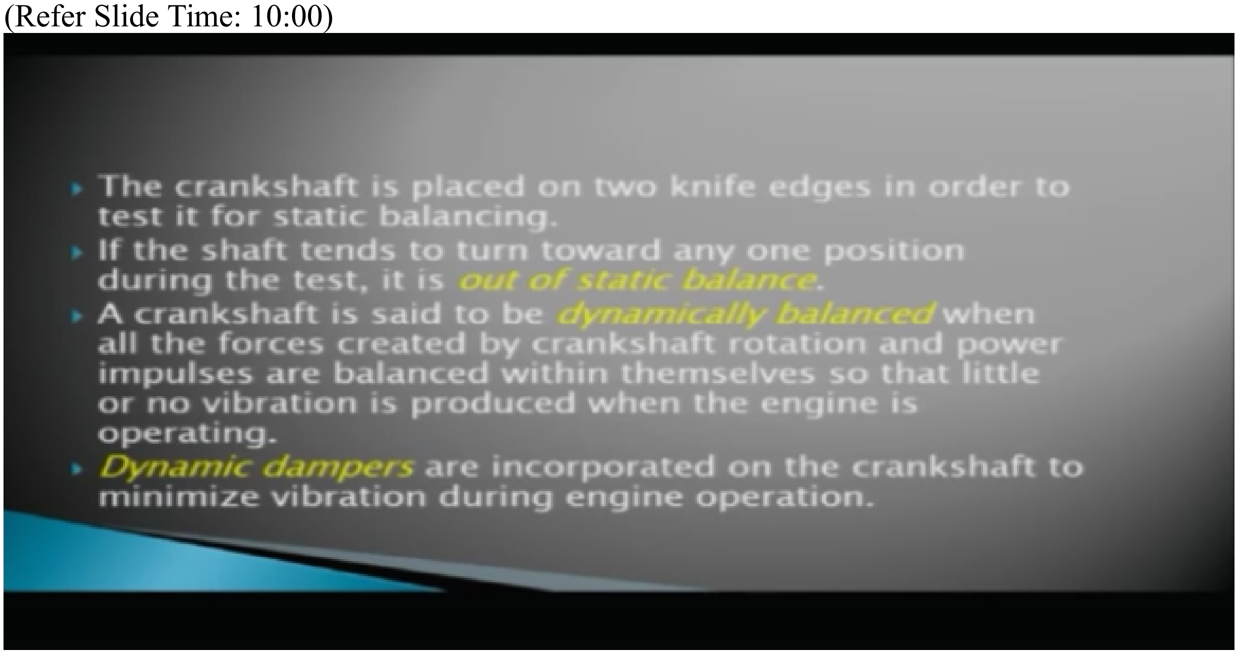

so in order to test the crankshaft whether it is statically balanced or not we need to place it on two knife edges, if the shaft tends to turn towards any one position during the test it is out of static balance.

A crankshaft is said to be dynamically balanced when all the forces created by the crankshaft rotation and power impulses are balanced within themselves so that little or no vibration is produced when the engine is operating, so all the forces which are created by crankshaft rotation and power impulses need to be balanced within themselves so that no vibration is produced within the engine while it is operating, in such a condition the crankshaft is said to be dynamically balanced.

Dynamic dampers are incorporated on the crankshaft to minimize vibration during engine operation, so in order to minimize vibration during engine operation, dynamic dampers are also incorporated.

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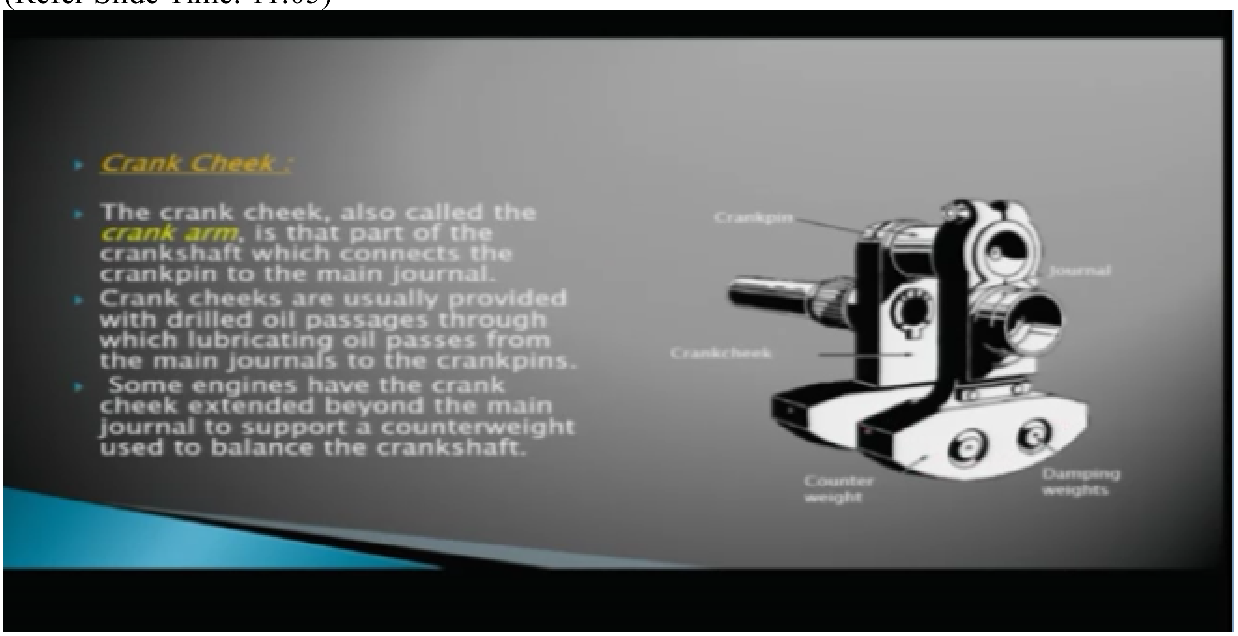

Here in this diagram you can see the crank cheek it has extended beyond the main journal to accommodate the dynamic dampers, here these are your counterweights and the counterweights have got the dynamic dampers.

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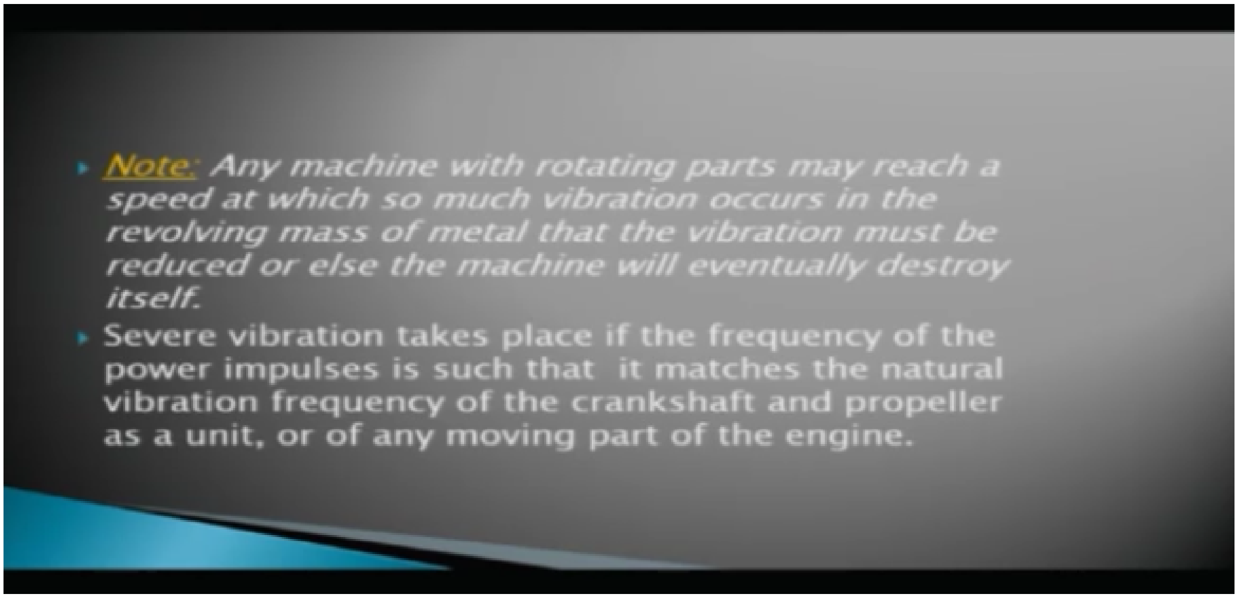

Any machine which has got rotating parts may reach a speed at which such vibration occurs in the revolving mass of metal that the vibration must be reduced or else the machine will eventually destroy itself.

Severe vibration takes place in the frequency of power impulses is such that it matches the natural vibration frequency of the crankshaft and propeller as a unit of any moving part of the engine, so in case the frequency of the power impulses matches the natural vibration frequency of the crankshaft and the propeller together severe vibration will take place.

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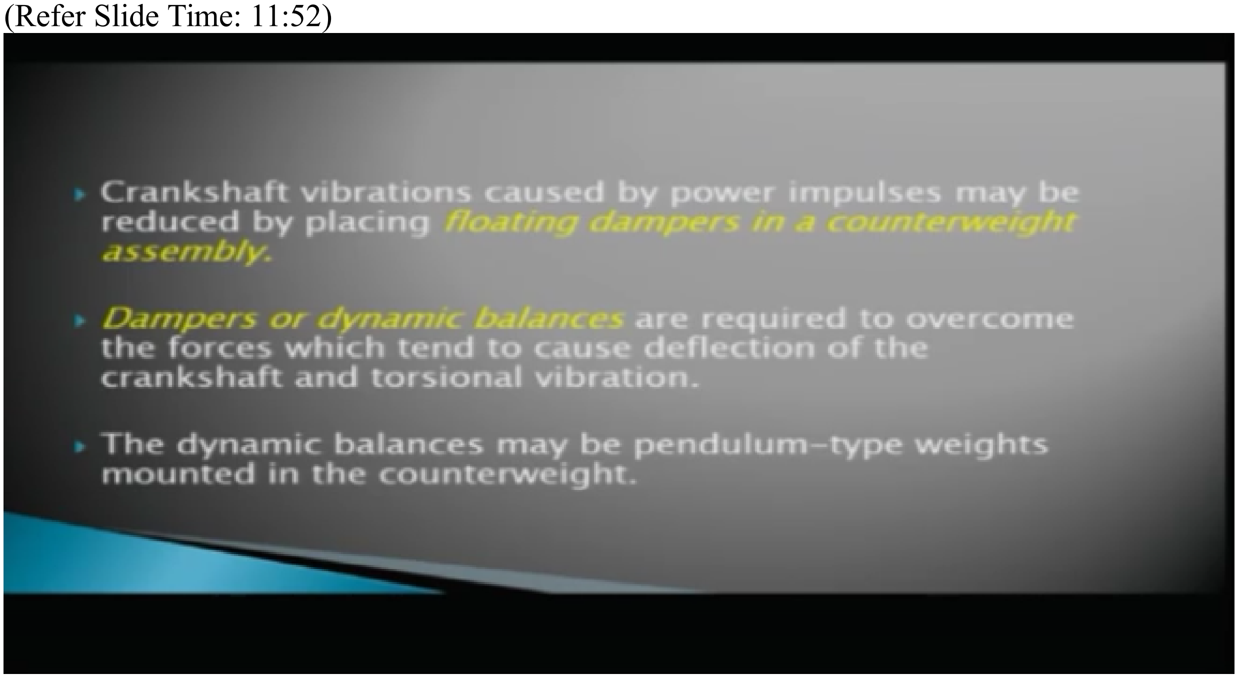

Crankshaft vibrations caused by power impulses may be reduced by placing floating dampers in a counterweight assembly, so we have seen in the diagram that in the counterweight assembly we can place floating dampers to reduce crankshaft vibrations caused by power impulses.

Dampers or dynamic balances are required to overcome the forces which tend to cause deflection of the crankshaft and torsional vibration, so these dampers they overcome the forces which can deflect the crankshaft and torsional vibration.

So the dynamic dampers, the dynamic balances they are pendulum type weights which are mounted in the counterweights,

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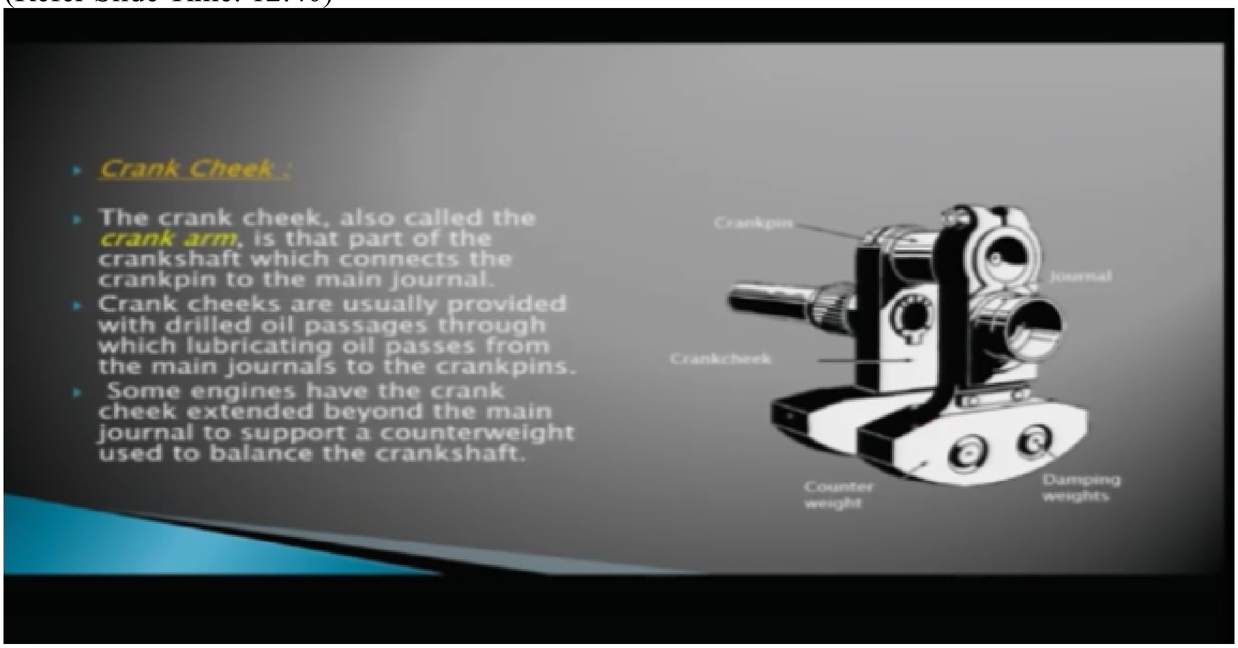

so in this diagram you see this is your counterweight, this is your counterweight assembly and within the counterweight assembly you have the dynamic dampers, they are pendulum type dynamic dampers to minimize vibration due to power impulses.

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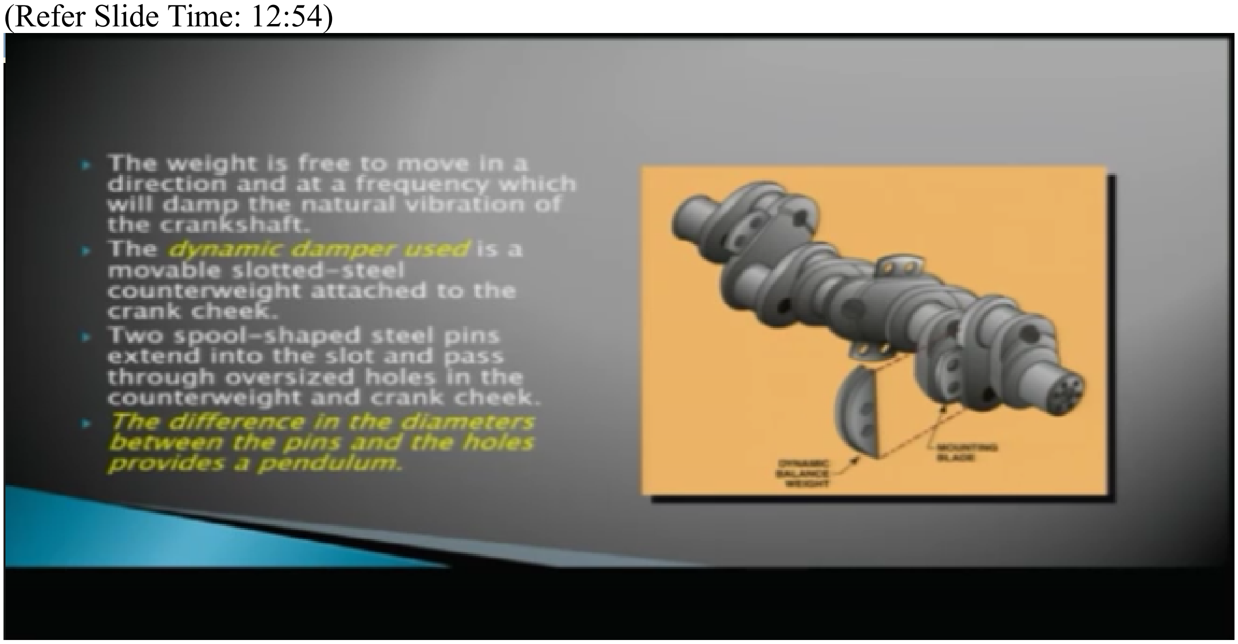

Here in this diagram also you can see these are your dynamic balance weights which are mounted on the crankshaft, the weight is free to move in a direction and at a frequency which will damped the natural vibration of the crankshaft.

The dynamic damper used is a movable slotted steel counterweight attached to the crankshaft cheek, so here you can see the dynamic damper used it is a movable slotted steel counterweight attached to the crank cheek, so you can see two spool shaped steel pins they extend into the slot and pass through the oversized holes in the counterweight and crank cheek. The difference in dia between the pins and the holes provides a pendulum.

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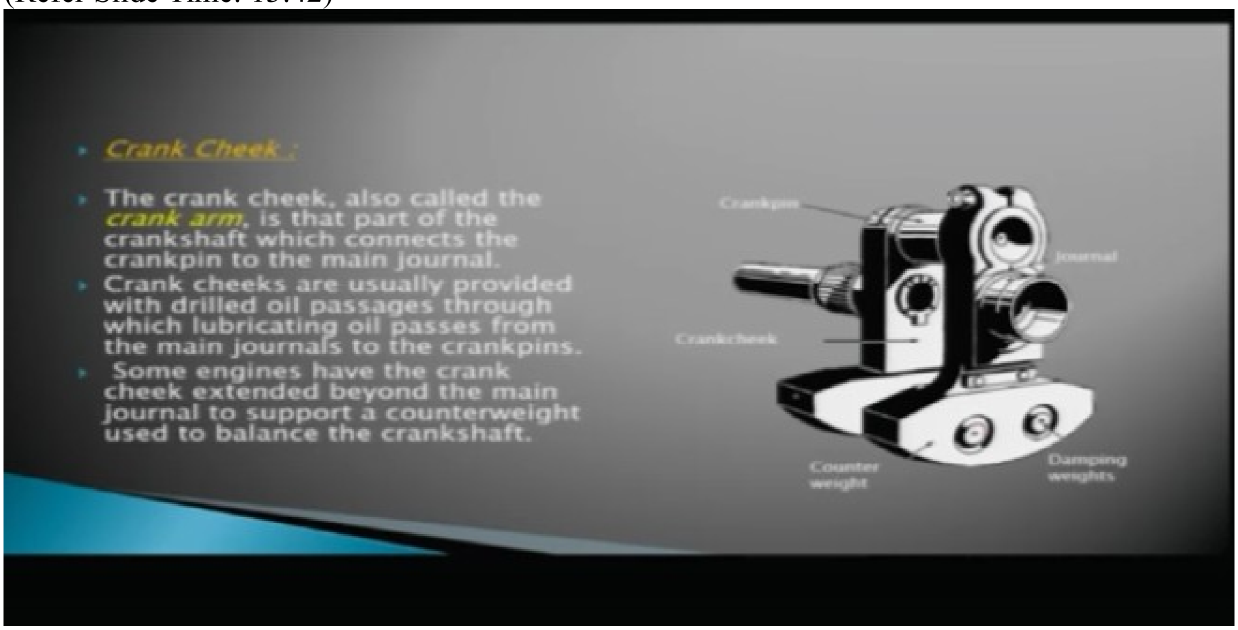
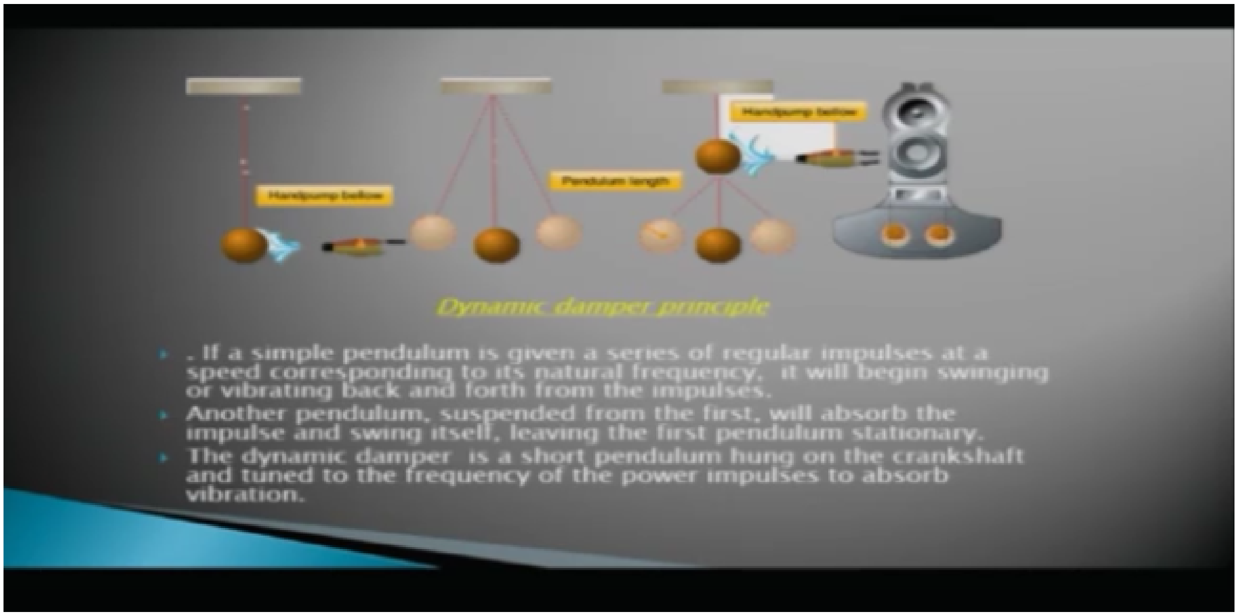


Here you can see these are two spools shaped steel pins which are placed in the oversized holes and this provides a pendulum effect. Here the dynamic damper principal is shown you can see (Refer Slide Time: 13:50)



if a simple pendulum is given a series of regular impulses at a speed corresponding to its natural frequency it will begin swinging or vibrating back and forth from the impulses, you can see this is your simple pendulum if it has given some power impulses it will begin swinging or vibrating back and forth from the power impulses, this is your normal pendulum effect.

Another pendulum suspended from the first, you can see this is your first pendulum, another pendulum is suspended from the first pendulum will absorb the impulse and swing itself leaving the first pendulum stationary, so the second pendulum which is suspended from the first pendulum will absorb the impulses and swing itself and will leave the first pendulum stationary.

The dynamic damper is a short pendulum hung on the crankshaft, so the dynamic damper it is a short pendulum hung on the crankshaft and tuned to the frequency of power impulses to absorb vibration, so this is how these dynamic dampers they will dampen the vibration.

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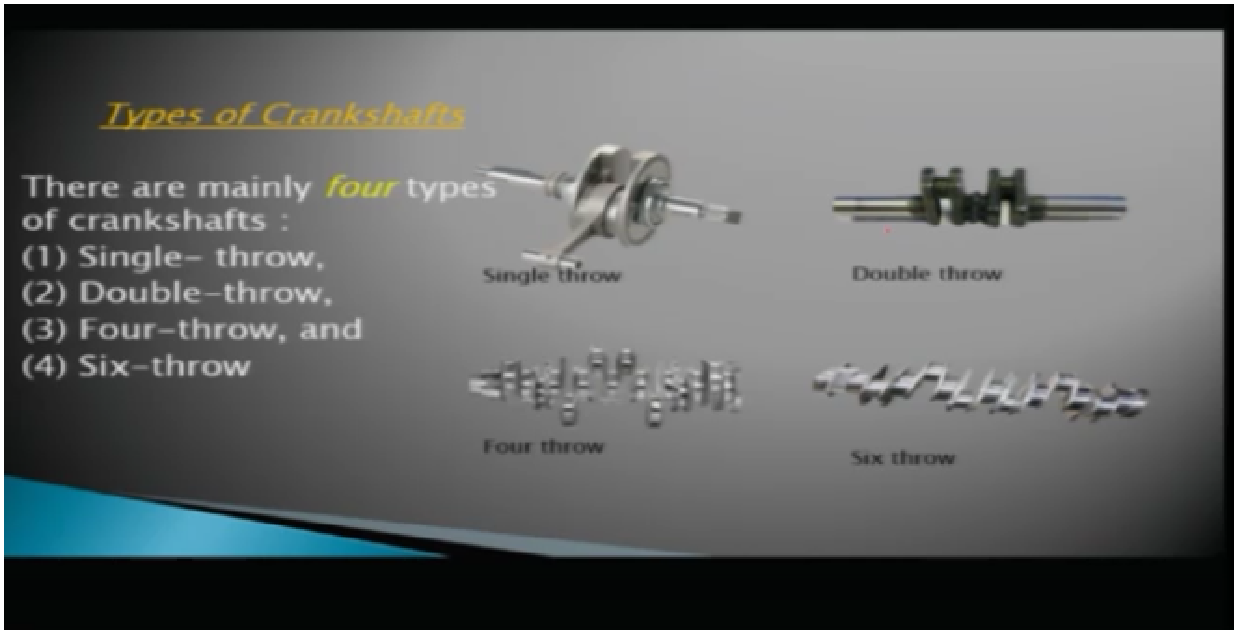

Now coming to types of crankshafts, there are various types of crankshafts mainly four types, single throw here in this diagram you can see this is your single throw crankshaft, double throw you can see two throws here one and two, double throw crankshaft, four throw here you have four throw crankshaft, and another one six throw, so single throw, double throw, four throw and six throw crankshafts.

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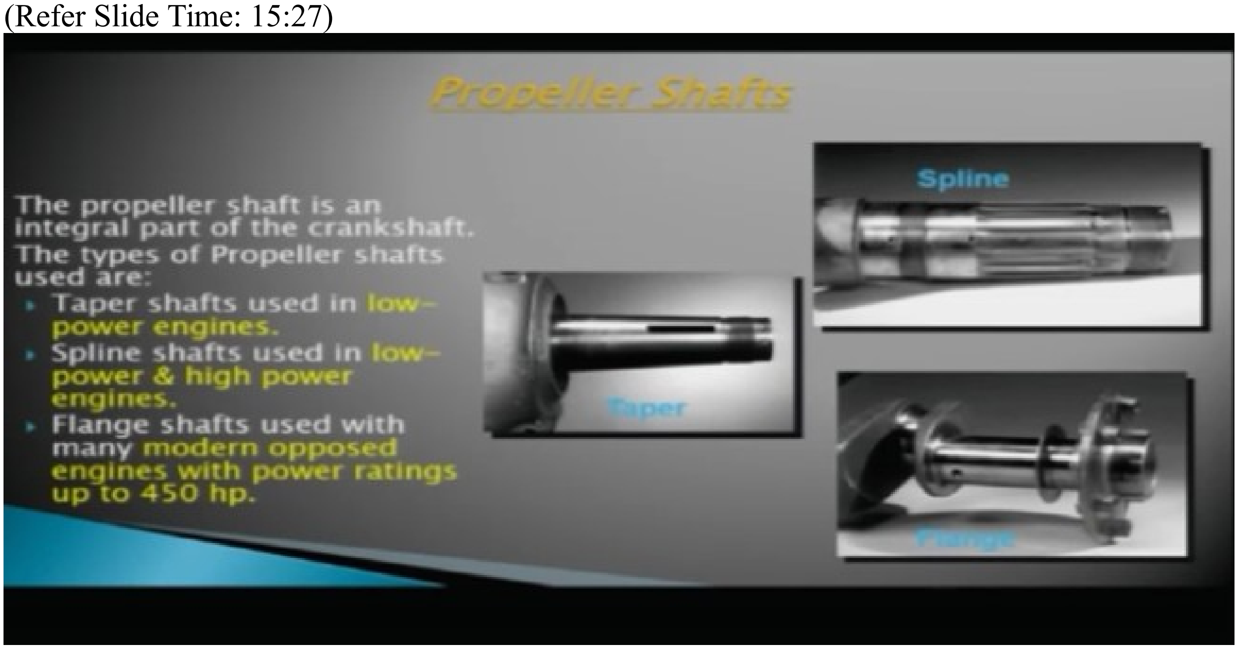

Now coming to propeller shafts, the propeller shaft it is an integral part of the crankshaft, and propeller shaft it is the shaft where you mount your propellers, propeller shaft are also an integral part of the crankshaft, there are various types of propeller shafts tapered shaft you can see here this is your tapered shaft you can see the tapered shaft here, then you have the spline shaft you can see various splines on the shaft, you can see the various splines so this is your spline shaft, and the flange shaft here you can see this, this is your flange, so this is your flange shaft.

The taper shaft is used in low power engines, this taper shaft is used for low power engines, spline shift this can be used on low power engines as well as the high power engines, and flange shaft is used for many modern opposed engines with power ratings up to 450 horsepower, so flange shaft is again used on modern engines with higher power ratings.

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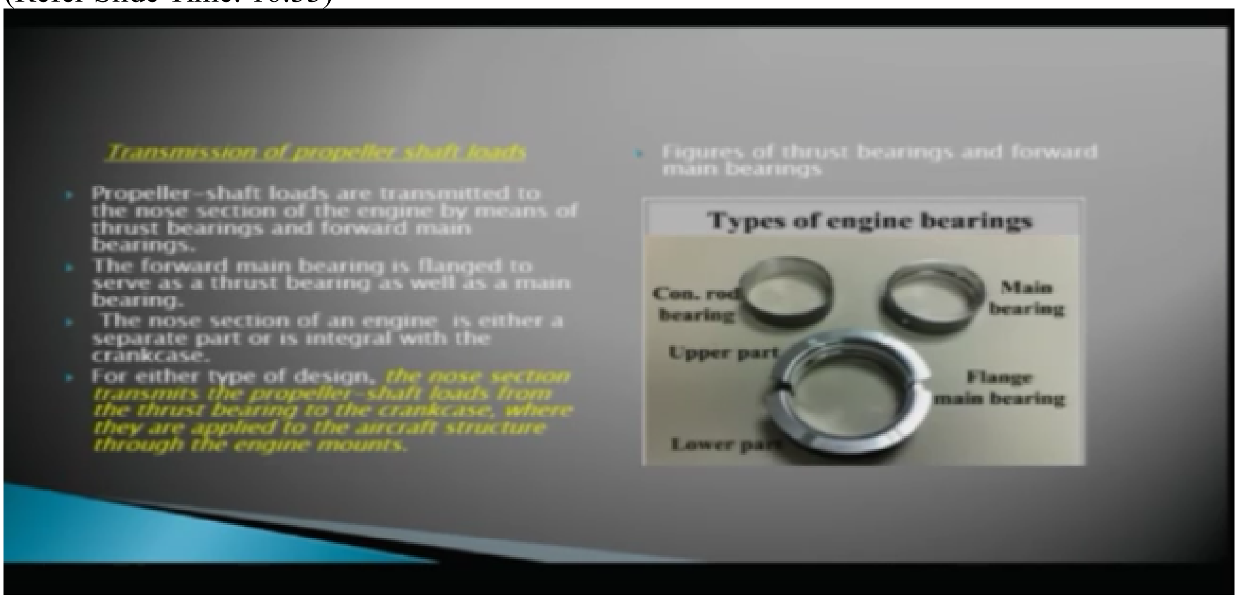

Now how do you transfer the propeller shaft load? The propeller shaft loads are transmitted to the nose section of the engine, so all the loads which are on the propeller shaft, the propeller shaft loads they are transmitted to the nose section of the engine by means of thrust bearings and forward main bearings, so you have the thrust bearing and forward main bearing, so by means of these bearings you transfer the propeller shaft load to the nose section of the engine. The forward main bearing is flange to serve as a thrust bearing as well as a main bearing, so you can see this is your forward main bearing, which is just flange to serve as a thrust bearing as well as a main bearing.

The nose section of an engine is either a separate part or as integral with the crank case, so the nose section of the engine it is either separate or integral with the crankshaft, for either type of design the nose section transmits the propeller shaft loads from the thrust bearing to the crank case where they are applied to the aircraft structure through the engine mounts, so any type of design the nose section will transmit the propeller shaft load from the thrust bearing to the crank case, so the propeller shaft loads are transferred from the thrust bearings to the crankcase and where they are applied to the aircraft structure through the engine mounts, this was all about crankshafts.

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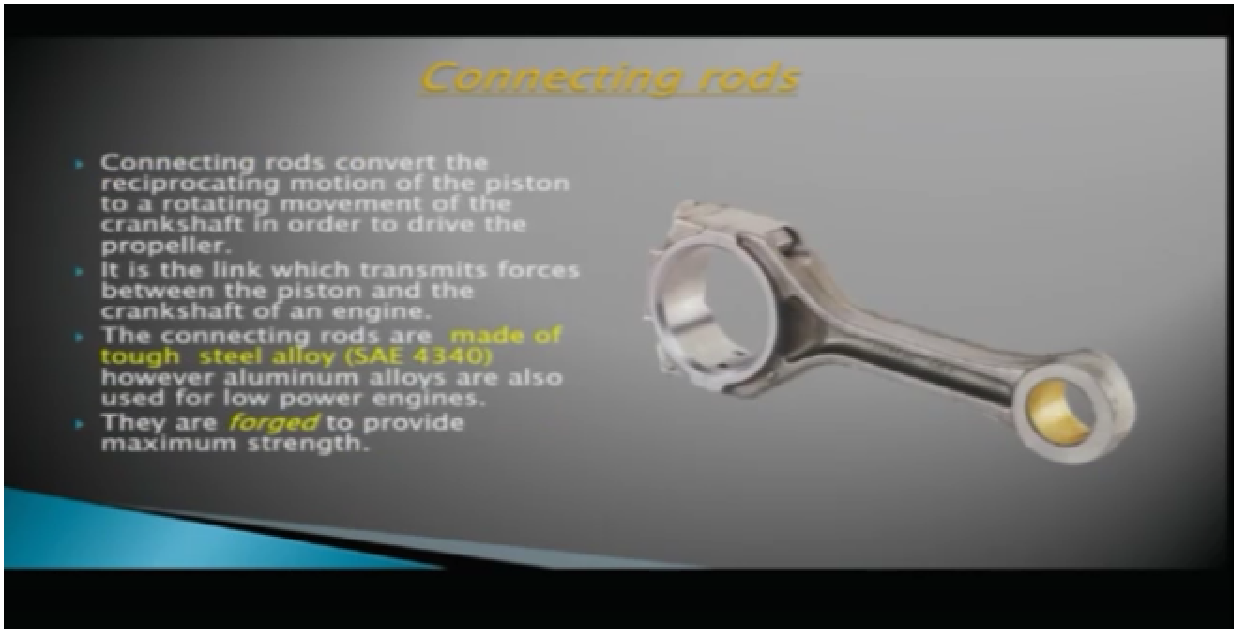

Now coming to connecting rods, the connecting rods basically convert the reciprocating motion of the piston to a rotating movement of the crankshaft in order to drive the propeller, so the basic purpose of the connecting rod is to convert the reciprocating motion of the piston to the rotary movement of the crankshaft, it is the link which transmits forces between the piston and the crankshaft of an engine, so you can see this is your connecting rod it has got two ends, this end this is connected to the piston, and the other end the bigger end this is connected to your crankshaft, so this is the link which will transmit the forces between the piston and the crankshaft of the engine, so this end is connected to the piston the reciprocating motion of the piston is converted to the rotary motion of the crankshaft, this end is connected to your crankshaft.

The connecting rods are also made of tough steel alloy mainly SAE4340, however in some low powered engines you can use aluminum alloys also, again the connecting rods are also of forged construction to provide maximum strength,

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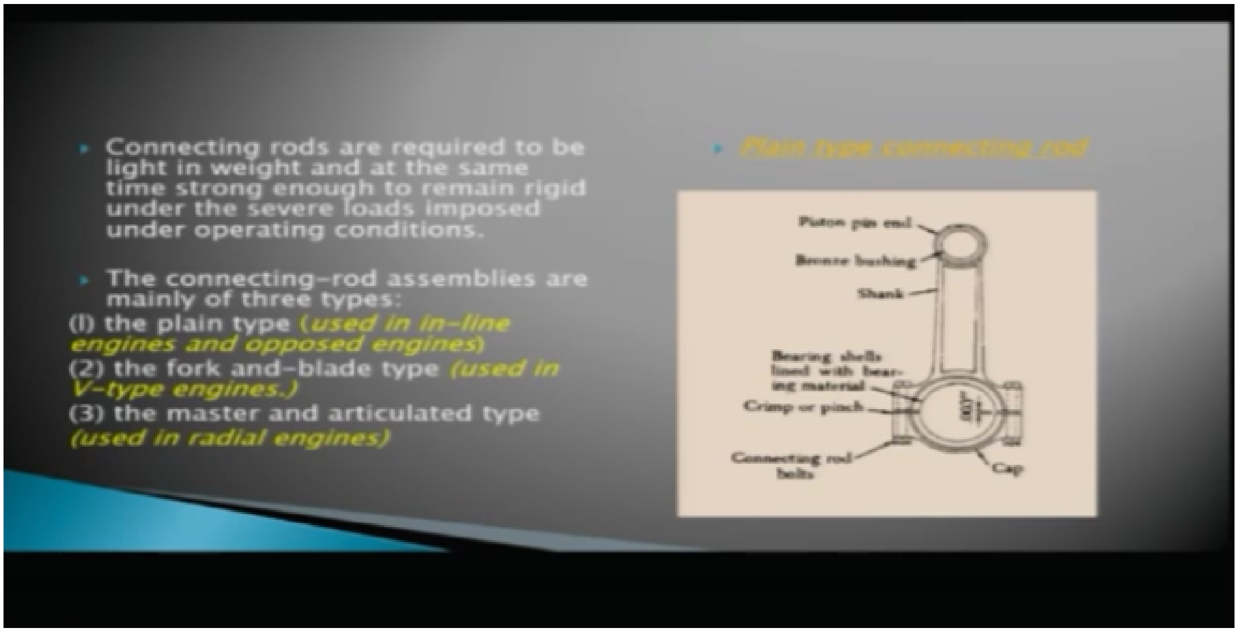

the connecting rods are required to be light in weight and at the same time strong enough to remain rigid under the severe loads imposed under operating conditions, so the connecting rods are required to be light in weight as well as very strong so that they are able to withstand the severe loads imposed under all types of operating conditions.

The connecting rod assemblies are mainly of three types, the plain type, the fork and blade type and the master and articulated type, so here in the diagram you can see a plain type connecting rod which is mainly used in inline engines and opposed engines, so here you see this is the small end this is your piston pin end, this is your bigger end which is your connecting rod end, so this end connects to the piston pin and this end connects to your crankshaft, this is here you have a bushing inside which is your bronze bushing, again this is your shank and this is your crankshaft end.

The second type is the fork and blade type which is used mainly on V type engines, and the third is the master and articulated type which is mainly used in the radial engines, so this diagram you can see the plane type connecting rod,
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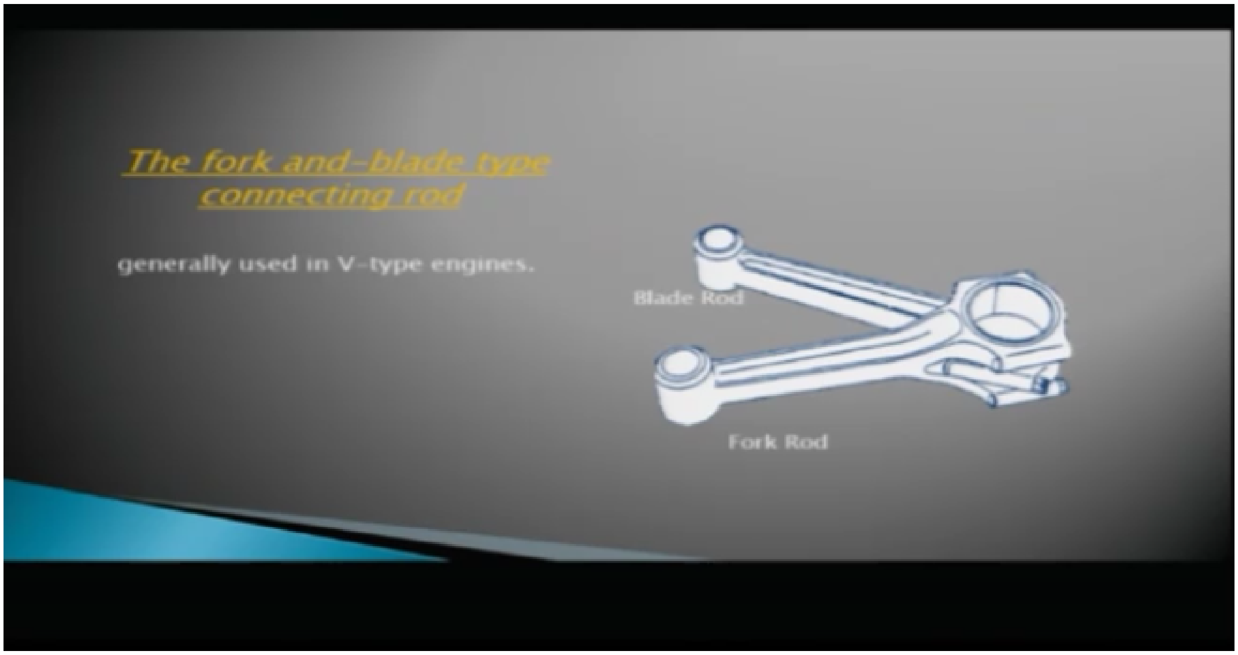

this diagram you see the fork and blade type connecting rod which is mainly used on V type engines, and this is your master and articulated type connecting rod which is mainly used for radial engines.

So generally we have three types of connecting rods plane type, fork and blade type, this is your plane type connecting rod, fork and blade type connecting rod as well as the master and articulated type connecting rod.

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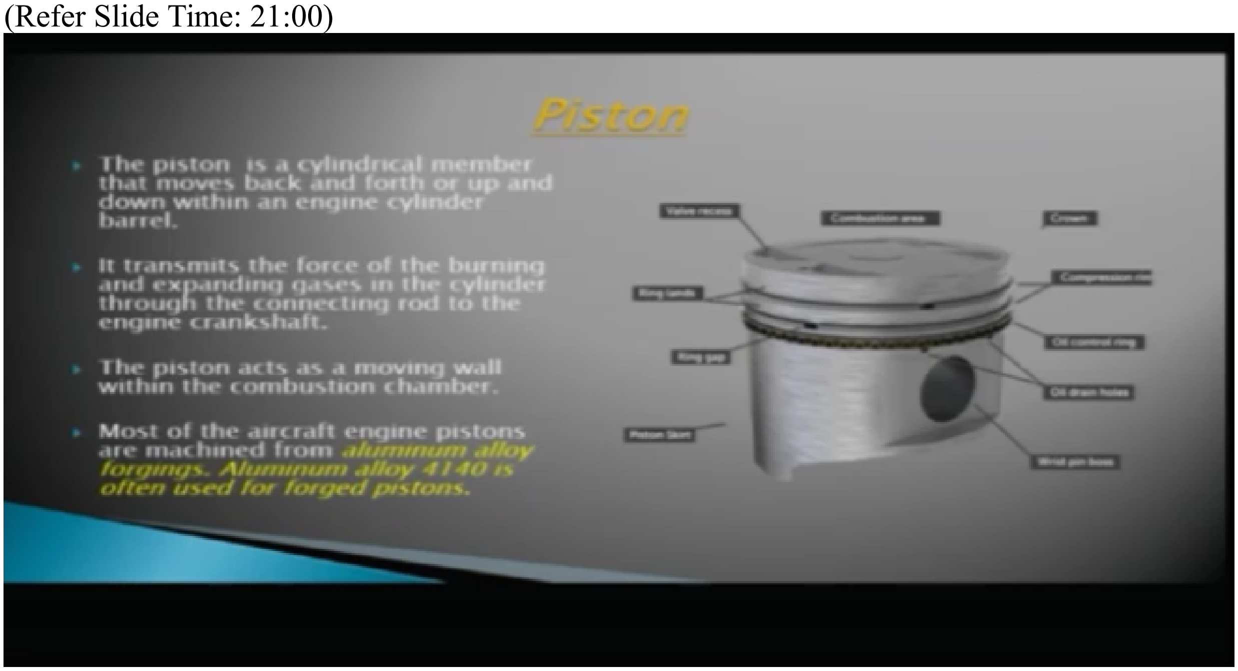

Now coming to piston, so piston it is a cylindrical member that moves back and forth or up and down within an engine cylinder barrel, so piston it is the cylindrical member in the diagram you can see a piston here, this is a cylindrical member which moves back and forth or up and down in an engine cylinder, it transmits the forces of the burning and expanding gases in the cylinder through the connecting rod to the engine crankshaft, so the piston will transmit the forces of the burning and expanding gases in the cylinder through the connecting rod to the engine crankshaft. The piston acts as a moving ball within the combustion chamber.

Now just above the piston this is your combustion area you can see here this is your combustion area where your fuel and air mixture is burning, so the pressure is created here and the piston moves up and down, so the piston is acting as a moving wall within the combustion chamber, most of the aircraft engine pistons are machined from aluminum alloy forgings, again this is also of a forged construction and forged from aluminum alloys. Aluminum alloy 4140 is often use for forged pistons.

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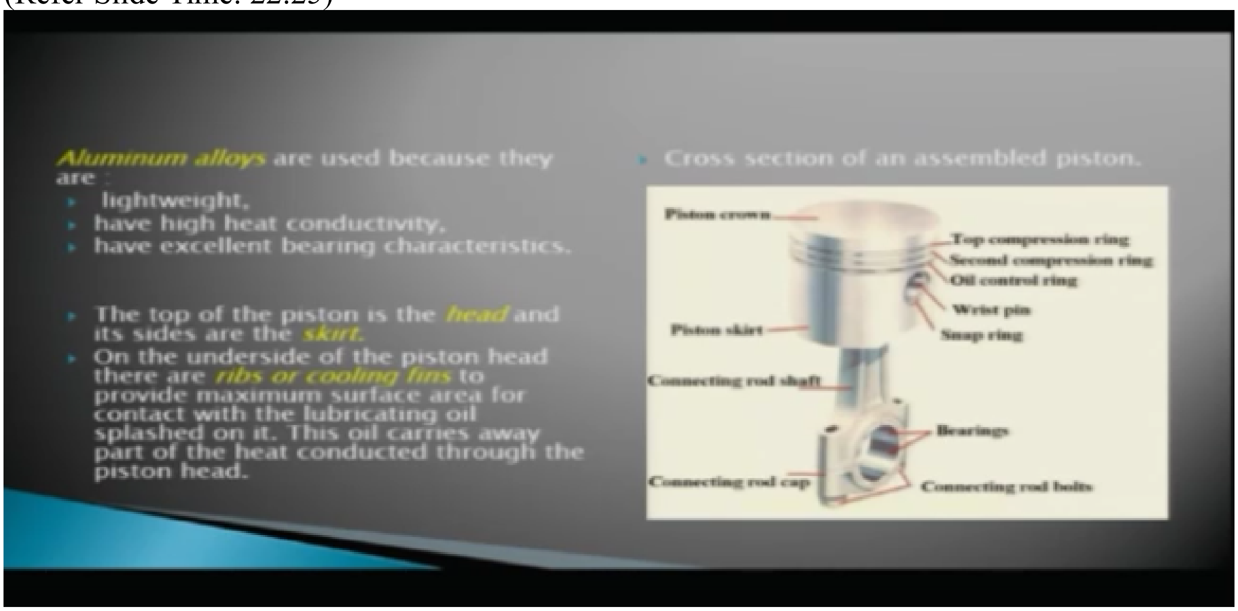

The basic purpose of using aluminum alloy is that they are light in weight, they have high heat conductivity and have excellent bearing characteristics, so aluminum alloys are used because they are very light in weight, they have very high heat conductivity property and have excellent bearing characteristics.

Here in the diagram you can see a piston and a connecting rod attached you can see the various parts of the piston, here the top of the piston this is called your piston crown, you have various rings on the piston, we will study about the rings further, there are various types of rings compression rings, oil control rings, this is the place where you put the piston pin, this is your pin, then this bottom portion this is your piston skirt and to the piston pin this is the place where your piston pin is attached to the piston pin this connecting rod is attached, one end of the connecting rod is attached to the piston pin, and another end of the connecting rod is attached to your crankshaft.

The top of the piston is the head and its sites other skirt, so top is the head and the sides are the skirt. On the underside of the piston head, so on the underside of the piston head there are ribs or cooling fins to provide maximum surface area for contact with the lubricating oil splashed on it, so the lower side of the piston head is ribbed or it has got cooling fins so that it provides maximum surface area for contact with the lubricating oil splashed on it, this oil carries away part of the heat conducted through the piston head.

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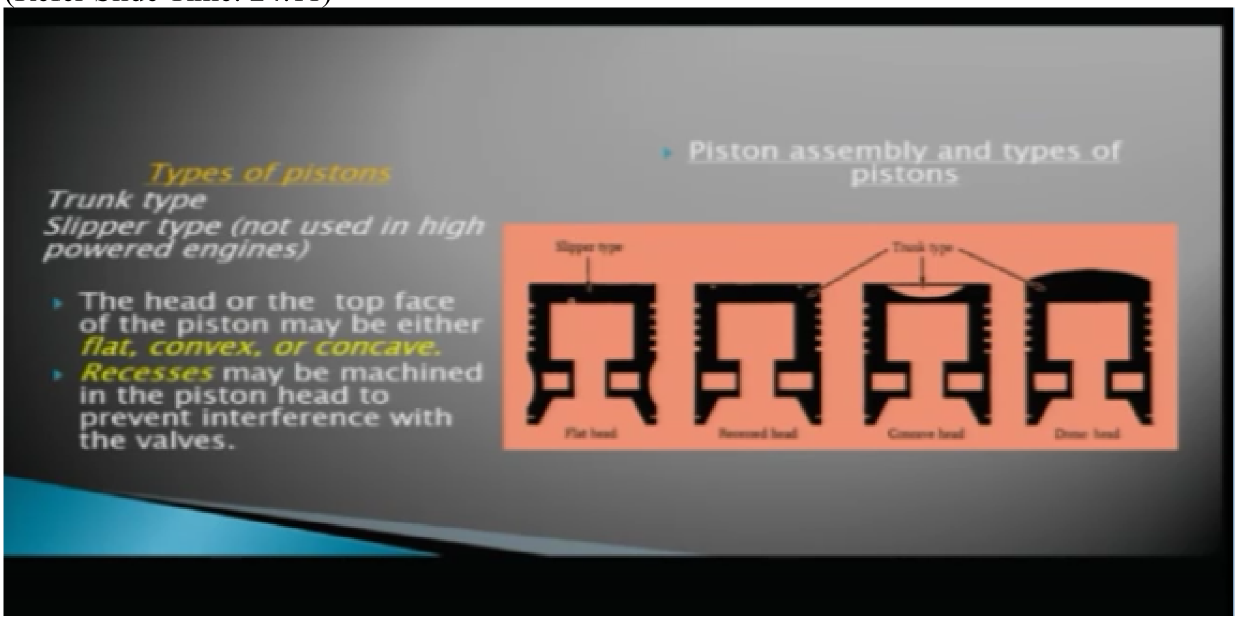

There are different types of pistons here in the diagram you can see trunk type, these are the trunk type pistons and another one is the slipper type, so here you can see these are your trunk type pistons, and another is the slipper type. So slipper type is not used in high powered engines, and the trunk types you can see their head you have different types of heads this is your flat head, this is your concave head, and this is your convex head, and on top of the pistons you have recesses machined to prevent interference with the valves, we will study about the valves and the valve operating mechanized, the recesses are machined on the piston heads to prevent interference with the valves.

Here you can see these are your recesses, so the valve recesses are provided on the top of the piston so that they do not interfere with the valves, we will study about the valves and the vavle operating mechanized in the further slides, grooves are machined on the outer side surface of the piston to receive the piston rings,

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so you can see here on the piston you have different grooves they are made to accommodate the piston rings.

The metal between the grooves here these are your grooves, and the metal between the grooves is called a groove land or a land, so generally around six grooves may be machined around the piston to accommodate the piston rings. The number of grooves may vary but in general around six grooves are machined on the around the piston to accommodate the piston rings, so here in the diagram you can see this is your piston this is on the top is the combustion area you have valve recesses to accommodate the valves the top of the piston is also called the crown you can see different grooves here where you can accommodate the rings these are your compression rings here, another groove you can have the oil control rings, you have the drain holes also, oil drain holes this is your place which is called a pin boss area where you have the piston pin, this side area this is called the piston skirt, between the piston rings you have the ring gap also, the area between the ring grooves is called the ring land, you can see this is your ring land.

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Now coming to piston rings the functions of the piston ring is to provide a seal to hold the pressure in the combustion chamber, so this is your piston and you have the grooves on the piston and the piston rings are there inside the grooves, the purpose of the piston ring is to provide a seal to hold the pressure in the combustion chamber, it also prevents excessive oil from entering the combustion chamber and also conducts the heat from the piston to the cylinder valves, so mainly three functions of the piston rings to provide a seal to hold the pressure in the combustion chamber, to prevent excessive oil from entering the combustion chamber and to conduct the heat from the piston to the cylinder valves. The types of piston rings used are compression rings and oil rings. Oil rings are also of two types, oil control rings and oil scrapper rings.

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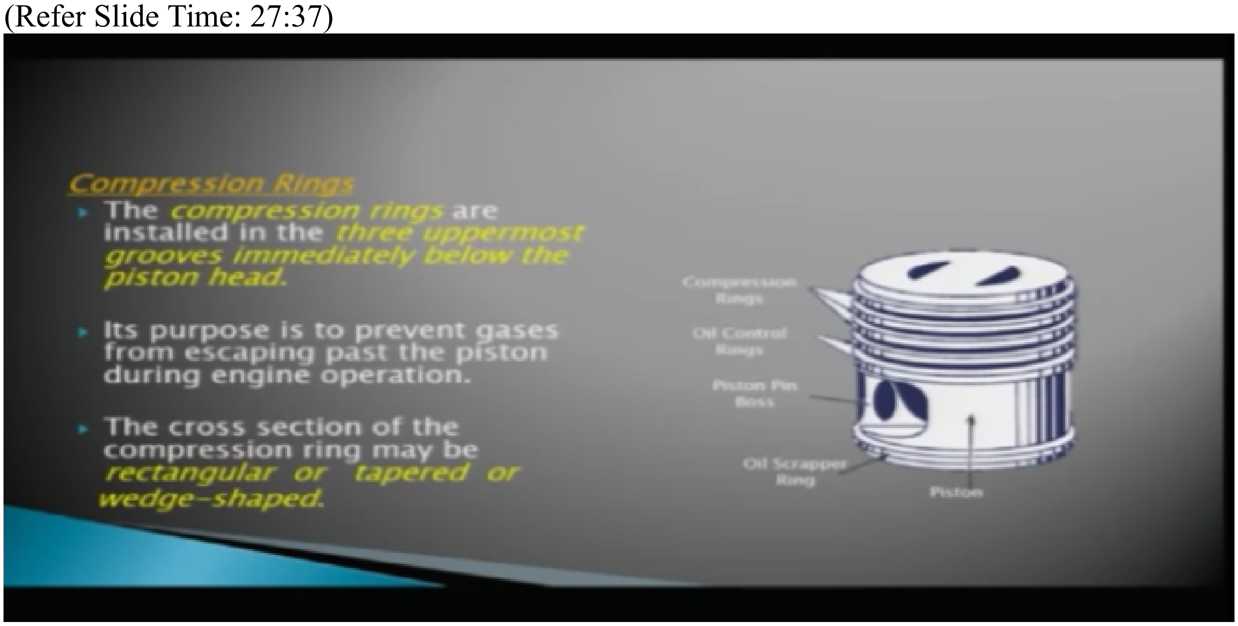

Now compression rings, the compression rings are installed in the three uppermost grooves immediately below the piston head, so just immediately below the piston head you have three grooves where you have got compression rings, so the purpose of the compression ring is to prevent the gases from escaping pass the piston during engine operation, the cross-section of the combustion ring may be rectangular or tapered or wedge-shaped, the compression ring cross section may be rectangular or tapered or wedge-shaped.

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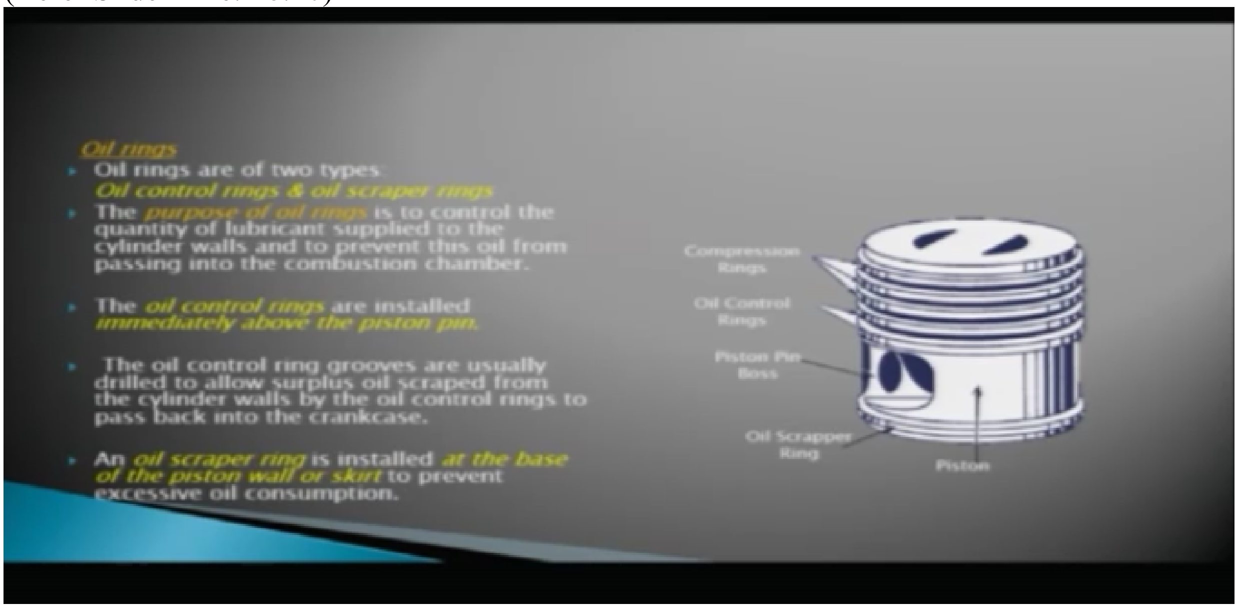

Coming to oil rings you see here in the diagram the first three grooves you have got the compression rings just below the piston head and below that you have got oil control rings, the oil rings are of two types, oil control rings and the oil scrapper ring, you see here this is your oil control ring and this is your oil scrapper ring, the purpose of the oil ring is to control the quantity of lubricant supplied to the cylinder valves and to prevent this oil from passing into the combustion chamber, so that is why they are called the oil control rings they control the quantity of lubricant being supplied to the cylinder valves and also prevent the oil from entering the combustion chamber.

The oil control rings are installed immediately above the piston pin, so this is your piston pin area, the place where your piston pin is installed and just above this piston pin area you have the oil control rings, the oil control rings grooves are usually drilled to allow surplus oil scrapped from the cylinder valves by the oil control rings to pass back into the crankcase, so these oil control rings also have drilled holes to allow the surplus oil to go back to the crankcase.

And you have the oil scraper ring installed at the base of the piston valve or a skirt to prevent excessive oil consumption, so here you see you have the oil scrapper ring which is installed at the bottom of the piston to prevent excessive oil consumption.
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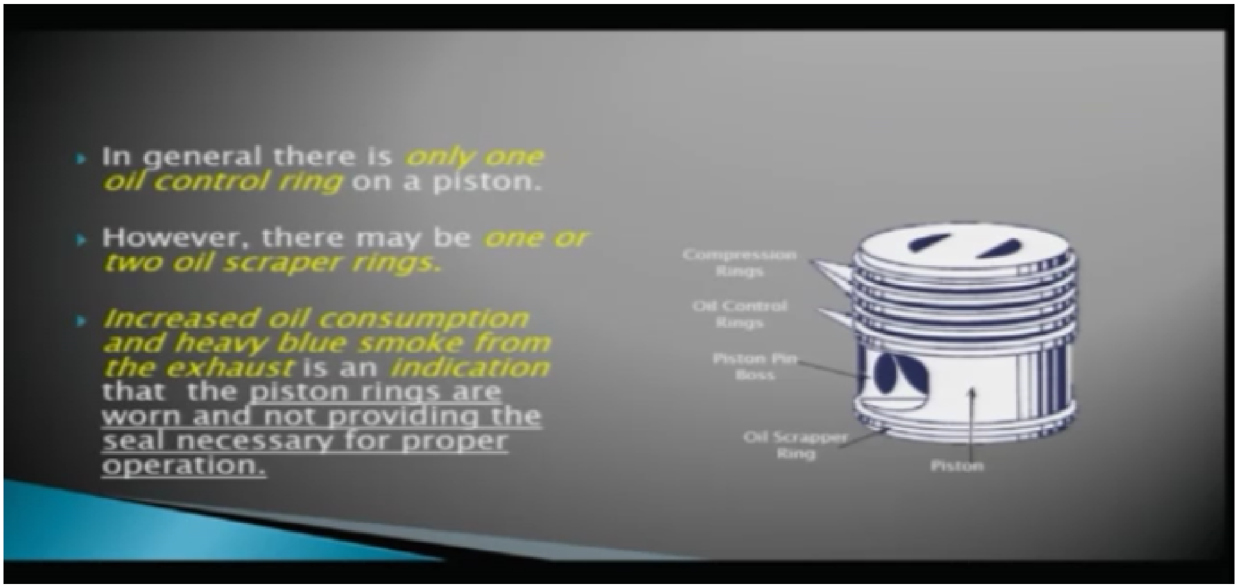

In general there is only one oil control ring on a piston however there may be one or two oil scrapper rings.

Now in case if you have increased oil consumption and you observe heavy blue smoke from the exhaust it indicates that your piston rings are worn and are not providing the seal necessary for proper operation, so increased oil consumption and heavy blue smoke coming from your exhaust indicates that your piston rings are worn out and are not providing seal necessary for proper operation.

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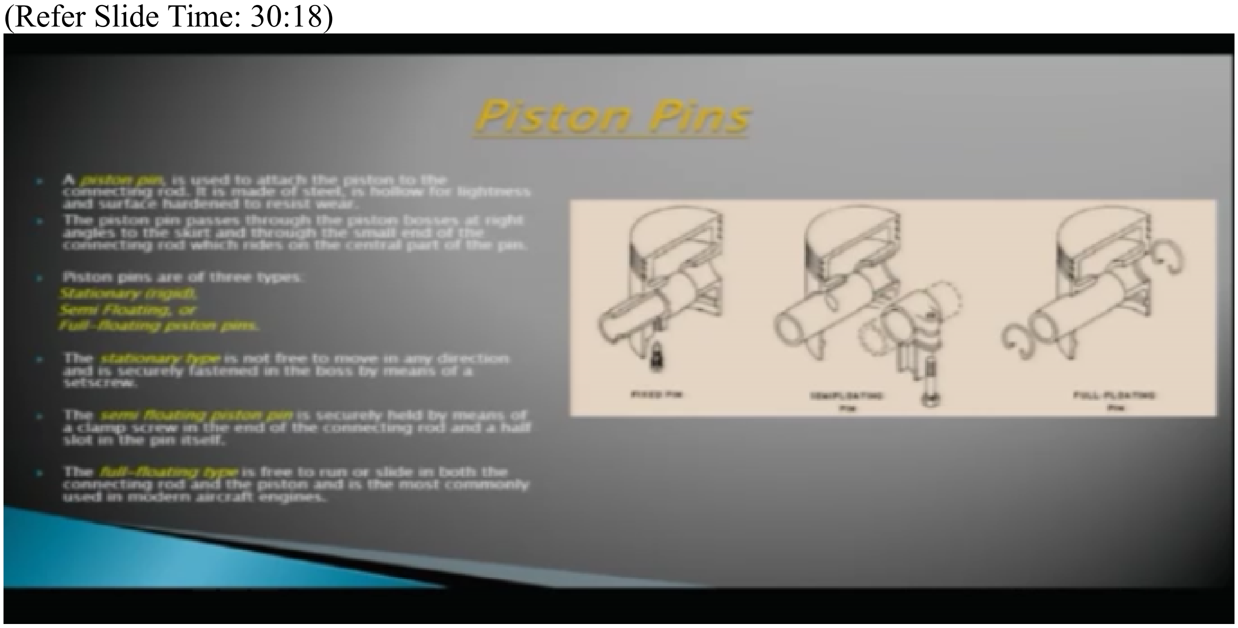

Coming to piston pins, so a piston pin is used to attach the piston to the connecting rod, so you see in the diagram this is your piston pin this is used to attach the connecting rod to the piston it is made of steel it is hollow for lightness and is surface hardened to resist wear, the piston pin passes through the piston bosses at right angles to the skirt through the small end of the connecting rod which rides on the central part of the pin, so this piston pin passes through the piston pin bosses at right angles to the skirt this is going, this is your piston, this is your piston pin boss area, and this piston pin slides inside the piston pin boss area at right angles to the skirt and the smaller end of the connecting rod is attached to the piston pin.

Piston pins are also of three types, the stationery type that is the rigid type here you can see this is your rigid type, the semi floating type and the full floating piston pin, the stationary type is not free to move in any direction and is securely fastened in the boss by means of a set screw, so rigid type it is stationary type it is fixed, it is not free to move in any direction, thus semi floating piston pin is held by means of a clamp screw in the end of the connecting rod and a half slot in the pin itself.

So the full floating type piston pin is free to move or slide in both the connecting rod as well as the piston and is most commonly used in modern aircraft engines, so in most of the engines we have the full floating piston pin used, full floating piston has the freedom to move in the piston as well as the connecting rod.

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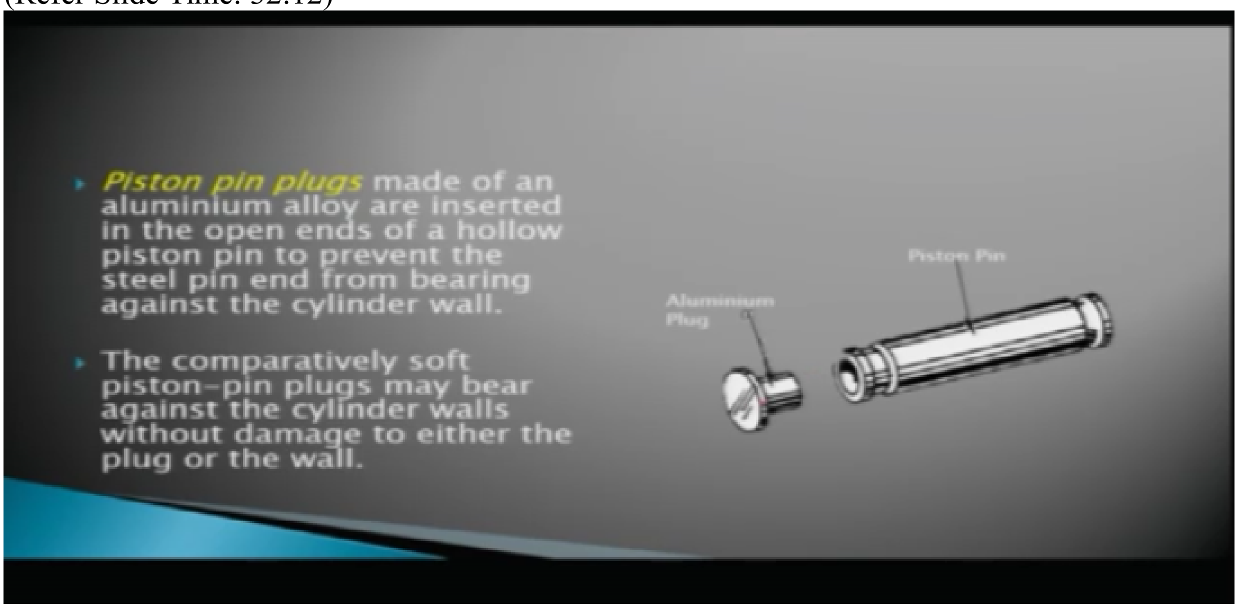

Now on sides of the piston you have the piston pin plugs which are made of aluminum alloy and are inserted in the open ends of the hollow piston pin to prevent a steel pin end from bearing against the cylinder valves, so in order to prevent the piston pin from bearing against the cylinder valves you have aluminum plugs on both sides of the piston pin, this comparatively soft piston pin plug may bear against the cylinder valves without damage to either the plug or the valve, so but these plugs are made of soft alloy and they do not damage the cylinder valves.

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Next is cylinders, the most important part of an engine, the cylinder one of the functions of a cylinder, the cylinder of an internal combustion engine develops power by converting the chemical heat energy of the fuel to mechanical energy, and transmits it through pistons and connecting rods to the rotating crankshaft, so the cylinder of any internal combustion engine will develop power by converting the chemical heat energy of the fuel to mechanical energy, so the cylinder you, inside the cylinder you have combustion taking place where your chemical heat energy is being converted to mechanical energy and is being transmitted through pistons and connecting rods to the rotating crankshaft.

The cylinder also dissipates a major portion of the heat produced by the combustion of the fuel, so in fuel combustion you have heat produced and cylinder plays an important role to dissipate major portion of the heat, the piston is and the connecting rods are housed in the cylinder, so within the cylinder you have the piston and a connecting rod moving, it also supports the valves and a portion of the valve operating mechanism, so here in the cylinder you can see these holes, these are for intake and exhaust, this hole this is for your spark plug connection, this is your cylinder head, this complete area you have this is your cylinder head, and this is your cylinder barrel this portion, and so the cylinder is housing a piston and connecting rod inside it provides space for the intake valve and the exhaust valve for the spark plugs to be mounted and your valve operating mechanism also is being mounted,

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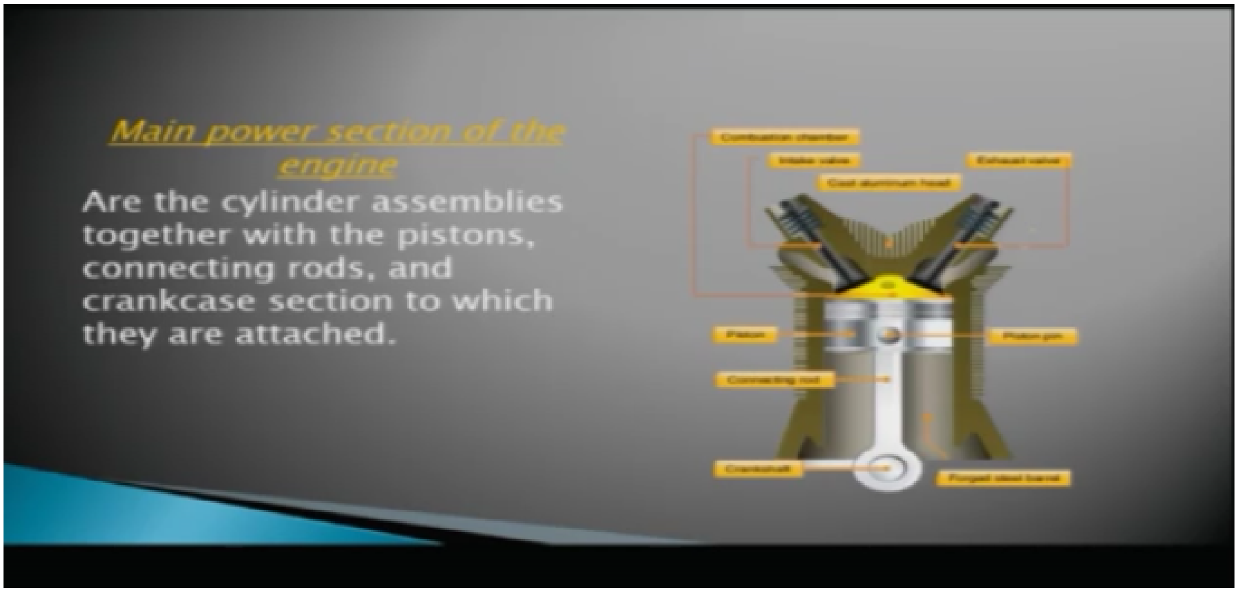

so it is the main power section of the engine they are the cylinder assemblies together with the pistons, connecting rods and crankcase section to which they are attached.

So here in the diagram you can see this is your cylinder, inside the cylinder you can see this is your piston, this is your connecting rod, to the connecting rod one end of the connecting rod is attached to the piston here to the piston pin, and another end of the connecting rod is attached to the crankshaft, on top of the piston you have combustion here, combustion is taking place fuel and air mixture is burning these are your valves, you can see here one is your intake valve, this is your exhaust valve, and this complete area this is your cylinder head area, and this is your cylinder barrel area, so the main power section of the engine is the cylinder assemblies together with the piston, connecting rods, and crankcase section to which they are attached.
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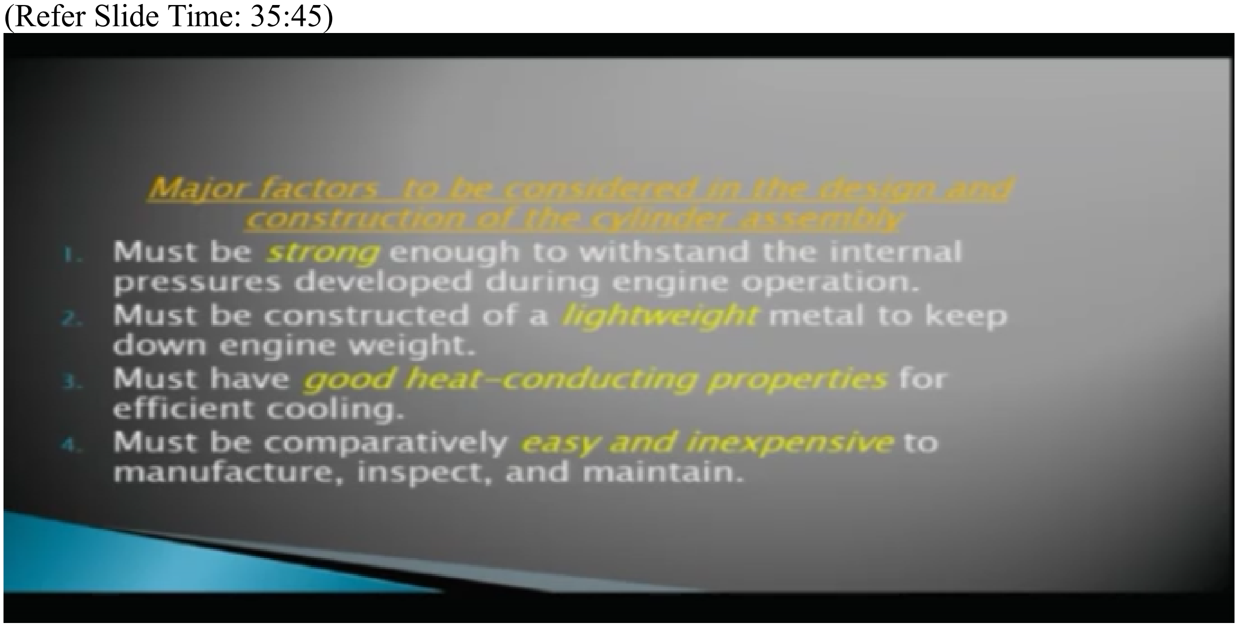

The major factors to be considered in the design and construction of cylinder assembly they must be strong enough to withstand the internal pressures developed during engine operation, so during engine operation you have combustion taking place within the cylinder, the cylinders must be very strong to withstand these internal pressures, because of combustion you have very high heat and pressure being developed inside the engine, so your cylinders must be strong enough to withstand this internal heat and pressure, they must be constructed of a lightweight metal to keep down the engine weight.

At the same time the cylinders also need to be very light in weight so that your engine weight is kept to a minimum, they must have good heat conducting properties for efficient cooling, because of high heat being generated due to combustion the cylinder must be made of a material so that it has good heat conducting properties, they must be comparatively easy and inexpensive to manufacture inspect and maintain, so these are the factors which are to be considered during the design and construction of the cylinder assembly, they must be strong and weight, they must be strong, must be light in weight, must have good heat conducting properties, and must be inexpensive.

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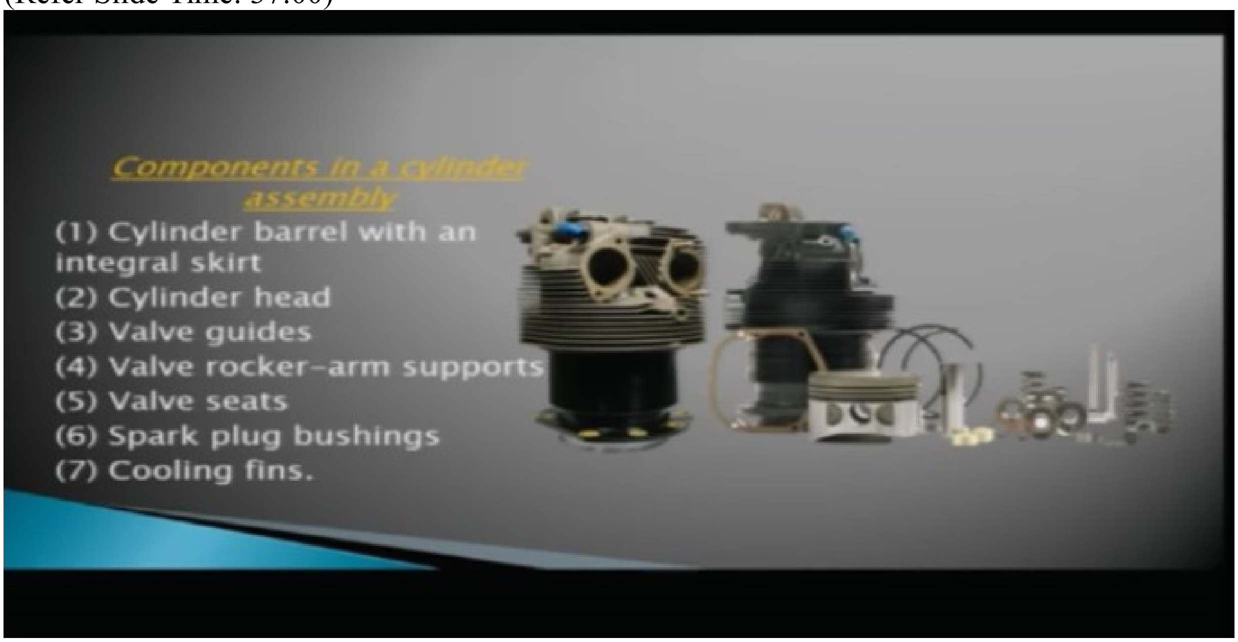

Now what are the various components in a cylinder assembly? You can see here in the diagrams, this is your cylinder barrel within integral skirt, this is your cylinder barrel here which has got a skirt here, this is your cylinder head area you have valve guides inside, then you have the valve rocker arm supports, you have the valve rocker arm supports, we will study about the valve guide, valve rocker arm supports, valve operating mechanism, but here you can see this is your intake and exhaust valve area, this is your spark plug area, this is your valve support area, then valve seats, spark plug bushings and the cooling fins, you can see here the cylinders they have the cooling fins also, you can see the fins here, so the main components in a cylinder assembly, cylinder barrel with skirt, cylinder head, valve guides, valve rocker arms, valve seats here, sparkplug bushings and the cooling fins.

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